CROPS & SOILS RESEARCH 1975

DEPARTMENT OF AGRONOMY
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INTRODUCTION

Research Program in the Department of Agronomy

This report gives the research in progress in the Department of Agronomy. The research program in the Department includes the development of improved crop varieties and improved soil and crop management practices that result in more efficient crop production. Considerable emphasis is also given to research on soil and water conservation, soil and water use, soil-water pollution, air pollution and the disposal of waste materials.

The wide range of soils and 2.0 million acres of agronomic crops (corn, soybeans, tobacco, small grain, turfgrasses, hay, and pasture) grown in the state with a value of approximately 289 million dollars emphasize the size and importance of the research program in agronomy. To solve crops and soils problems research work is conducted at University Laboratories, on the outlying Experiment Station Farms, and cooperatively with farmers, golf course superintendents, and others throughout the state. The help and cooperation received from the many people in the state in carrying out our research program is greatly appreciated.

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The Response of Alfalfa to Ground Limestone and "Liquid Lime"

Jay Angle and J.H. Axley
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Purpose and Objectives

A new product composed primarily of trihydroxy glutaric acid (a complex organic molecule) mixed with some calcium has been claimed by its promoters to have in one gallon of the product the equivalent liming effect of 500 lbs. of good ground limestone. This product is referred to as "Liquid Lime."

A greenhouse experiment was conducted with alfalfa to evaluate ground limestone and "Liquid Lime."

Procedure

Six treatments of "Liquid Lime" (0, 1, 2, 3, 6, and 12 gallons per acre) were compared with the equivalent of 0, 500, 1,000, 1,500, 3,000, and 6,000 lbs. of ground limestone per acre as pure $Ca(OH)_2$. The Beltsville silt loam soil which had received the equivalent of one of the above treatments was placed in pots in the greenhouse and seeded to alfalfa. The treatments were replicated four times and the experiment was run for eight weeks. Boron, di-potassium phosphate, and rhizobium innoculum were added equally to all pots. The alfalfa was watered every other day. At the end of the experiment the crops were harvested and weighed and the pH (acidity) of the soil in each pot was determined.

Results

Data in Table 1 shows that "Liquid Lime" applied at 6 gallons or more per acre resulted in an increase in the yield of alfalfa over the untreated (no lime) soil. However, yields from the lime treated soils were better than those from soils treated with the amount of "Liquid

Lime" claimed to be equivalent to limestone. The soil pH at the end of the two-month experimental period was changed very little by the "Liquid Lime." It can be noted that with 3,000 lbs. per acre of limestone equivalents the soil pH was increased to 6.9 as compared to 5.4 for no lime.

Summary

"Liquid Lime" increased the growth of alfalfa much less than the lime. Lime resulted in larger increases in soil pH than the recommended quantity of "Liquid Lime."

Table 1. Influence of "Liquid Lime" and ground limestone on alfalfa yields and soil pH

Treatment		Average fresh wt. of alfalfa	Final Soil pH
"Liquid Lime"	1 gal/a	1.55 c*	5.4 x
Ground Limestone	500 lbs/a	2.25 c	5.5 x
"Liquid Lime"	2 gal/a	1.95 c	5.7 x
Ground Limestone	1000 lbs/a	3.07 b	6.3 x
"Liquid Lime"	3 gal/a	1.65 c	5.7 x
Ground Limestone	1500 lbs/a	2.20 c	6.3 x
"Liquid Lime"	6 gal/a	2.47 b	5.3 x
Ground Limestone	3000 lbs/a	3.52 ab	6.9 y
"Liquid Lime"	9 gal/a	2.77 b	5.3 x
Ground Limestone	4500 lbs/a	4.7 b	7.1 y
"Liquid Lime"	12 gal/a	3.32 ab	5.2 x
Ground Limestone	6000 lbs/a	5.62 a	7.1 y
No Limestone		1.62 c	5.4 x

* Duncan's Range test

Average weights or pH values followed by the same letter are not significantly different at the 5% probability level according to Duncan's range test.

Performance of Maryland Tobacco Varieties and Breeding Lines, 1974

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Purpose and Objectives

The Official Variety Test is the final phase of the breeding program and has three main objectives: (1) To obtain additional information on the varieties presently being grown by the majority of the tobacco farmers, (2) to evaluate advanced breeding lines which appear to have potential as a new variety, and (3) to provide a guide to Maryland tobacco farmers for use in choosing a variety to produce their best crop.

Procedures

Each year the variety tests are conducted at three locations with varying soil types. The tests are located on a Monmouth fine sandy loam at Upper Marlboro, Galestown loamy sand at Davidsonville, and Beltsville silt loam at Dentsville.

The 1974 test which is included in the present report contained six varieties and ten breeding lines. Eight breeding lines in the test were developed by the USDA at Beltsville under the direction of H. A. Skoog. Two breeding lines were Agricultural Experiment Station entries, B304 and B305, from the Botany Department.

Four replications of a randomized complete block design were used at each location. Each plot consisted of one row of 23 competitive plants. The plots were three feet apart and plants spaced two feet apart in the plot. Fifteen competitive plants per plot were cut at harvest.

The various agronomic and chemical characteristics measured and methods of data collection have been outlined by Aycock *et al.*, 1972, Maryland Agr. Exp. Sta. MP 798.

Results

The average performance of the varieties and breeding lines compared at three locations in 1974 is shown in Table 1. Md. 64 was the highest yielding variety with 1920 pounds of cured leaf per acre. Md. 872 and Md. 201 produced about 200 pounds less cured leaf per acre than Md. 64, but these two new varieties had a higher dollar per hundredweight value than Md. 64. Md. 609 was the best quality variety with an average of $86.72 per hundredweight. Several breeding lines compared very favorably with the best varieties. J-73-304-1 and J-73-304-2 were the highest yielding breeding lines. The value of these two breeding lines also compared very favorably with the standard varieties. The varieties and breeding lines ranged from 2.25% (Md. 872) to 3.06% (J-73-304-2) for total alkaloids. Significant variation was noted also among most of the other agronomic, physical, and chemical traits measured. Several breeding lines compared very favorably with the standard varieties for these traits.

Summary

The variety testing program was conducted at three locations in 1974. Several breeding lines with multiple disease resistance appear to have a real potential as new varieties.

Acknowledgment

The computer time for the statistical analyses was made available through the facilities of the Computer Science Center of the University of Maryland.

Table 1. Performance of Maryland tobacco varieties and breeding lines at three locations, 1974.

Variety or breeding line	Yield per acre (lbs.)	Value $/A	Value $/cwt	Plant height (in.)	Leaves per plant	Internode length (in.)	Days to flower	Total alkaloids (%)	Total nitrogen (%)	Duration of burn (sec./leaf)	Filling capacity (cc/g)
Md. 10	1607	1392	86.39	26.8	18.2	1.46	49.3	2.36	2.57	4.8	7.23
Md. 59	1643	1422	86.39	27.1	16.6	1.62	51.5	2.85	2.78	6.5	6.95
Md. 609	1657	1438	86.72	25.9	16.2	1.58	54.2	2.56	2.99	7.6	7.11
Md. 64	1920	1614	84.03	24.4	18.4	1.31	53.0	2.47	2.78	6.2	7.36
Md. 872	1734	1503	86.44	24.0	15.9	1.47	51.3	2.25	3.03	6.4	6.90
Md. 201	1724	1489	86.22	24.0	17.5	1.36	53.0	2.61	2.78	6.4	7.18
J-73-1-1	1767	1516	85.65	26.4	19.5	1.35	53.0	2.58	2.64	5.3	7.43
J-73-224-1	1710	1470	85.87	25.9	17.6	1.45	52.5	2.57	2.90	6.6	7.17
J-73-225-1	1745	1486	85.19	28.0	17.4	1.59	52.0	2.32	2.85	7.4	6.95
J-73-304-1	1845	1608	87.02	26.9	17.1	1.56	53.2	2.99	2.68	5.6	7.09
J-73-304-2	1843	1596	86.33	25.3	17.5	1.42	53.8	3.06	2.88	5.7	7.08
J-73-307-1	1756	1530	86.88	27.7	18.4	1.48	53.4	2.90	2.82	6.0	7.58
J-73-313-1	1679	1445	85.87	27.4	16.9	1.61	49.2	2.42	2.86	7.4	7.20
J-73-340-1	1762	1508	85.41	22.6	17.9	1.25	53.0	2.51	2.82	7.0	6.95
B304	1486	1283	86.08	27.1	17.5	1.53	51.9	2.88	2.98	6.4	7.08
B305	1488	1284	86.06	26.0	16.1	1.57	53.3	2.70	3.05	5.3	6.91
Mean	1710	1474	86.03	26.0	17.4	1.48	52.4	2.63	2.84	6.3	7.14
L.S.D. (0.05)	116	107	1.15	2.7	1.2	0.12	1.8	0.30	0.24	N.S.	N.S.
(0.01)	157	143	1.55	N.S.	1.6	0.16	2.4	0.40	N.S.	N.S.	N.S.
C.V. (%)	8.2	8.1	1.0	7.6	7.5	5.0	2.4	11.4	8.9	31.7	7.7

Performance of Breeding Lines in the Preliminary Variety Test, 1975

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Purpose and Objectives

The initial phase of a breeding program is developmental. Following a desired cross or series of crosses, selection for superior lines is conducted for a number of segregating generations. As new lines reach homozygosity information concerning agronomic and chemical performance is needed. The preliminary variety test is the initial screening process for new breeding lines. Superior breeding lines in this test are then included in the Official Variety Test for further evaluation.

Procedures

In 1974 a group of near homozygous lines with resistance to black shank and/or tobacco mosaic were selected from the tobacco breeding nursery for yield and quality evaluations. These breeding lines were tested in 1975 at Upper Marlboro.

Twenty-six breeding lines and four standard varieties (Md. 609, Md. 10, Md. 64 and Md. 872) were included in the test. The experimental design was a randomized complete block with three replications.

Results

The performance of the 26 breeding lines and the standard varieties is shown in Table 1. Entry 23 exhibited the highest yield and dollar return per acre of all entries in the test. Entry 10 had the highest dollar per hundredweight value ($93.29) of all entries, but was not significantly higher than the standard Md. 609. Considerable variation was observed also among the various breeding lines for days to flower and total alkaloids.

After an additional seed increase in the breeding nursery, the top breeding lines from this test will be advanced to the Official Variety Test, and also used as breeding material in future crosses.

Summary

The performance of several breeding lines was very good when compared with the standard varieties. These breeding lines will be advanced to the Official Variety Test, and also used as breeding material in future crosses.

Acknowledgment

The computer time for the statistical analyses was made available through the facilities of the Computer Science Center of the University of Maryland.

Table 1. Performance of breeding lines of Maryland tobacco in a preliminary variety trial at Upper Marlboro, Md., 1975.

Entry	Yield per acre (lbs.)	Value $/A	Value $/Cwt	Days to flower	Total alkaloids (%)
1	1554	1442	92.77	54.0	1.13
2	1453	1343	92.30	52.3	1.21
3	1405	1304	92.83	53.0	1.06
4	1425	1328	92.96	54.3	1.38
5	1538	1419	92.17	54.0	1.46
6	1477	1374	92.95	53.0	1.28
7	1600	1469	91.72	52.7	1.28
8	1447	1309	90.37	51.7	1.05
9	1507	1361	90.26	51.7	1.11
10	1519	1418	93.29	56.3	1.12
11	1389	1288	92.49	52.7	1.31
12	1400	1302	93.05	53.0	1.21
13	1617	1501	92.79	54.0	1.24
14	1465	1349	91.90	59.0	1.45
15	1485	1355	91.22	53.3	1.29
16	1539	1411	91.63	53.3	1.15
17	1526	1414	92.59	54.3	1.06
18	1525	1418	92.94	52.7	0.95
19	1434	1320	91.96	55.0	1.39
20	1390	1266	91.05	54.7	1.16
21	1575	1411	89.54	53.7	0.88
22	1608	1449	90.10	52.3	1.00
23	1789	1619	90.54	54.7	1.05
24	1606	1454	90.13	55.7	1.07
25	1689	1533	90.56	56.7	1.22
26	1565	1431	91.30	58.0	1.24
Md. 872	1549	1398	90.30	54.3	0.92
Md. 10	1414	1259	88.92	51.7	1.26
Md. 64	1589	1390	87.46	57.3	0.98
Md. 609	1505	1376	91.63	54.0	1.30
Mean	1519	1390	91.46	54.1	1.17
L.S.D. (0.05)	N.S.	N.S.	2.43	2.3	0.27
(0.01)	N.S.	N.S.	3.24	3.0	0.36
C.V. (%)	9.3	10.3	1.6	2.6	14.1

Breeding for Disease Resistance in Maryland Tobacco, 1975

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Department of Agronomy

Purpose and Objectives

A number of diseases attack tobacco grown in southern Maryland; therefore, a large part of the breeding program at the University of Maryland is concerned with disease resistance. In past years the tobacco mosaic virus was one of the most destructive diseases and until 1969, none of the varieties being grown had mosaic resistance (3). At the present time three mosaic resistant varieties (1, 3, 4) and two black shank resistant varieties (2) are available for production. Other diseases which cause some loss in Maryland tobacco each year are black root rot (Thielaviopsis basicola), wildfire (Pseudomonas tabaci), black shank (Phytophthora parasitica var. nicotianae), and fusarium wilt (Fusarium oxysporum var. nicotianae). At present the tobacco breeding program is concerned with developing varieties with resistance to three diseases -- tobacco mosaic, black shank, and fusarium wilt.

Procedures

Breeding for Black Shank Resistance. The sources of resistance to black shank presently being used are from Md. 59 and Md. 609, two varieties released in 1965; and L8, a burley tobacco variety. Md. 59 and Md. 609 were developed by Dr. O. D. Morgan, and the source of black shank resistance was from Florida 301. L8 contains resistance from Nicotiana longiflora.

During January and February, 1975 a modification of a black shank screening procedure utilized at the University of Kentucky was used to screen 90 entries in the F_2 to F_7 generations. The procedure involved

planting approximately 10 to 15 seeds of an entry in two vermiculite-filled 50 ml polypropylene centrifuge tubes. About 4 weeks after seeding the seedlings were inoculated with the black shank fungus. Two weeks after inoculation the entries were scored on above ground plant parts (leaves and stems) and the roots. A scoring system of 0, 1, 2, 3 and 4 was utilized for the leaves and stems with a score of 0 representing no symptoms of the disease and a score of 4 representing complete death of all seedlings. A similar system was used for rating the roots. A rating of 0 represented no symptoms (roots white) and 4 represented severe browning of the entire root system.

Breeding for Mosaic Resistance. During the summer of 1974, 29 breeding lines in the F_2 to the F_7 generations were screened for mosaic resistance in the breeding nursery in the field. Each entry was represented by 28 plants. Just prior to flowering, plants were inoculated with the tobacco mosaic virus by rubbing the leaf with cheesecloth saturated in a solution of the virus. Approximately one week after inoculation, ratings were made on the number of resistant and susceptible plants in each entry. At the time of scoring the resistant plants exhibited small necrotic spots at the site of inoculation while the unsceptible plants exhibited the characteristic mosaic pattern of dark and light green areas in the new growth. The necrotic spots of the resistant plants are due to a hypersensitive reaction of the leaf tissue to the virus. When the virus contacts the leaf cells, the cells die at such a rapid rate that the virus cannot spread.

Results

Black Shank Resistance. The results of the screening procedure for black shank resistance are presented in Table 1. Considerable variation was found among the entries for black shank resistance. A few entries ap-

peared to have complete resistance while others were completely susceptible. From the leaf and stem scores, 77.8% of the entries received a score of 1.5 or better while 40% of the root scores fell within this same range. Entries with a leaf and stem score of 1.5 would probably have adequate resistance under field conditions in southern Maryland.

One reason for the wide variation among the entries for black shank resistance could be due to the nature of inheritance of the resistance. Resistance from the Florida 301 source is believed to be dependent upon two major genes and several modifiers; therefore, through breeding the ultimate objective is to capture the two major genes and accumulate as many of the modifiers as possible. Resistance from L8 is simply inherited and produces plants with a very high level of resistance.

Mosaic Resistance. The results of the tobacco mosaic screening procedure are shown in Table 2. Resistance is determined by a single dominant gene; therefore, the plants fell into one of two classes -- resistant or susceptible. Screening results showed that all entries were resistant. For the entries, 41.4% appeared to be homozygous or true breeding and 58.6% were heterozygous or still segregating at the mosaic resistant locus.

Summary

Breeding lines with resistance to black shank and tobacco mosaic are being developed. Screening techniques which are relatively simple and reliable are being used in the greenhouse and summer breeding nursery. Lines with good resistance based on greenhouse and field results were advanced an additional generation in the field nursery during the summer. Selection for plant type and other desirable agronomic traits was done in the field nursery.

Some of the breeding lines which have good resistance and desirable plant types have been observed for agronomic acceptance in preliminary field trials under replicated conditions.

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3. Skoog, H. A. and M. K. Aycock, Jr. 1969. Maryland 10: A mosaic resistant variety of Maryland tobacco. Maryland Agr. Exp. Sta. MP 734.

4. Skoog, H. A. and M. K. Aycock, Jr. 1974. Maryland 201, a new variety of Maryland tobacco. Maryland Agr. Exp. Sta. MP 845.

Table 1. Percentage distribution of entries screened for black shank resistance in the greenhouse, 1975. (N = 90).

Score class [a]	Breeding material	
	Leaves and stems	Roots
0.0	6.7	11.1
0.5	21.1	7.8
1.0	27.8	0
1.5	22.2	21.1
2.0	13.3	16.7
2.5	6.7	31.1
3.0	2.2	5.6
3.5	0	6.6
4.0	0	0

[a] 0 = completely resistant; 4 = dead.

Table 2. Percentage of resistant (AA), segregating (Aa), and susceptible (aa) genotypes screened for tobacco mosaic resistance, field nursery, 1974. (N = 29).

Genotype	Breeding material, %
AA	41.4
Aa	58.6
aa	0

Genetic Analysis of the Yellow Burley Genes in Maryland Tobacco

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Department of Agronomy

Purpose and Objectives

The amphidiploid nature of Maryland tobacco (Nicotiana tabacum L.), which has arisen from a natural cross of N. sylvestris and probably N. tomentosiformis (6), provides an opportunity for certain characters to be controlled by duplicate factors. With the presence of a dominant allele at either of the loci, but not both, the resulting segregation ratio would be 3:1 in the F_2; however, the presence of both dominant loci renders a 15:1 ratio in the F_2 normally found for duplicate dominant epistasis (9). Clausen (2) has indicated that duplicate loci in the subgenomes may become functionally diploidized through mutation, resulting in simple 3:1 ratios.

Henika (7) has reported that duplicate genes designated G_1 and G_2 are involved in the production of the normal green color of the tobacco plant. The recessive alleles g_1 and g_2 are both essential to produce the white burley phenotype. Clausen and Cameron (3) have reported similar results and have referred to the character as yellow burley.

In a study of 20 non-burley tobacco cultivars, which included three Maryland cultivars, Stines and Mann (10) found many of the cultivars possessed the unmodified duplicate dominant condition. The Maryland cultivar Robinson Medium Broadleaf contained the dominant alleles at both loci while Catterton and Posey had one dominant locus. The two genes producing the yellow burley color has been designated yb_1 yb_1 and yb_2 yb_2 by Clausen and Cameron (3) and Stines and Mann (10).

The duplicate recessive factors for the determination of the yellow burley character in several types of N. tabacum has aroused considerable interest as to the genetic constitution of more contemporary Maryland tobacco cultivars. The objective of this study was to determine the genotypes of seven Maryland cultivars with respect to the yellow burley character.

Procedures

Burley 21 (Bu 21) was the source of the yellow burley character ($yb_1\ yb_1$, $yb_2\ yb_2$) used in this study. Seven Maryland cultivars were crossed with Bu 21. They were Catterton, Wilson, Maryland 10 (Md. 10), Maryland 59 (Md. 59), Maryland 609 (Md. 609), Maryland 64 (Md. 64), and Moore. The F_1 hybrids from all crosses were normal green in color. An F_1 plant in each cross was self pollinated and backcrossed to Bu 21 to produce the F_2 and backcross (BC) generations.

Seed from the F_2 and BC generations for each cross were seeded in clay pots (10.2 cm in diameter) in the greenhouse. When the seedlings were approximately 7 cm in height, they were transplanted to 5 x 5 x 6 cm bands and later transplanted to the field nursery when the seedlings were normal transplant size, 18 cm in height. Total number of plants transplanted and scored in each generation is shown in Table 1. The plants were classified into one of two classes at maturity: normal green or yellow burley.

A chi-square test was calculated for each generation to determine its goodness to fit to the expected ratios. The pooled and heterogeneity chi-squares also were calculated.

Results

The observed genetic ratios for the BC and F_2 generations for each family are shown in Table 1. Ratios involving the Moore cultivar were approximately 3 green to 1 yellow burley in the BC generation and 15 green to 1 yellow burley in the F_2 generation. These ratios would suggest that Moore contained the dominant alleles at both loci for normal green color. The genetic ratios observed for the other six cultivars were 1 green to 1 yellow burley in the BC generation and 3 green to 1 yellow burley in the F_2 suggesting that these cultivars contained the dominant allele for normal green plant color at one locus only.

The pooled chi-square is nonsignificant for the BC generation, but significant at the 5% level for the F_2 generation. These results indicate a deficiency of recessives in the F_2 generation. Lower zygotic viability of the yellow burley genotype could have influenced the observed ratios at two periods during the life cycle of the plant. First at germination and/or secondly at the transplanting period from clay pots to bands. Smaller plants at transplanting would be discriminated against and a large percentage of these plants probably contained the yellow burley genotype. Also it was impossible to distinguish color differences at time of transplanting.

The heterogeneity chi-squares for the BC and F_2 generations are not significant and indicate the families are a homogenous population with the deficiency of recessives being constant for all cultivars. Two exceptions were noted. Md. 59 and Md. 609 had a higher number of yellow burley than normal green genotypes. Comparative studies on germination and seedling vigor of isogenic lines for the yellow burley character in Maryland tobacco would be helpful in providing answers for the deficiency of yellow burley plants observed in the segregating ratios.

The results in this study for the Catterton cultivar are similar to those reported by Stines and Mann (10), that is, Catterton contains the domiant alleles at one locus. Location of the recessive locus yb yb in these seven cultivars was not possible; however, Stines and Mann (10) have shown through monosomic analysis that the recessive yb locus in Catterton is in chromosome 0.

The diploidization of the Maryland cultivars could have arisen through hybridization with burley or some other type. In 1952 Bowling et al (1) indicated that the origin of Catterton is obscure, but thought to be a selection from a cross of a white burley strain on Maryland Broadleaf. Garner (4) has reported that a cross involving Maryland Broadleaf and white burley was made as early as 1905 in Maryland. Therefore, it appears that the development of Maryland cultivars with one dominant yb gene could have arisen very easily through hybridization. These data also support the statement by Garner et al (5) that burley probably arose as a mutation from Maryland around 1864 in Ohio.

Stines and Mann (10) reported that the Maryland cultivar Robinson Medium Broadleaf contained the dominant alleles at both yb loci. Md. 59 and Md. 609 cultivars tested in the present study were developed from a cross of Robinson x Florida 301 (8), but contained only one dominant yb gene. Therefore these results would suggest that Florida 301 contained only one dominant gene from normal green color.

Summary

Seven Maryland tobacco cultivars were crossed with Bu 21 in order to determine the genetic constitution of the cultivars from the yellow burley character. The results from the backcross and F_2 generations indicate that six cultivars (Catterton, Md. 10, Wilson, Md. 59, Md. 609, and Md. 64) contain one dominant gene, and the Moore cultivar contains two genes for normal green color.

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Table 1. Segregation of backcross and F_2 generations for the yellow burley character derived from crossing seven Maryland tobacco cultivars with Bu 21.

Family	Generation	Observed ratio: Normal green	Observed ratio: Yellow burley	Total	Expected ratio	X^2	P
Catterton x Bu 21	BC	64	56	120	1:1	0.533	0.30 - 0.50
	F_2	114	36	150	3:1	0.080	0.70 - 0.80
Wilson x Bu 21	BC	70	50	120	1:1	3.333	0.05 - 0.10
	F_2	116	34	150	3:1	0.436	0.50 - 0.70
Md. 10 x Bu 21	BC	75	45	120	1:1	4.500	0.02 - 0.05
	F_2	122	27	149	3:1	3.595	0.05 - 0.10
Md. 59 x Bu 21	BC	53	67	120	1:1	1.633	0.20 - 0.30
	F_2	117	33	150	3:1	0.720	0.30 - 0.50
Md. 609 x Bu 21	BC	56	64	120	1:1	0.533	0.30 - 0.50
	F_2	118	32	150	3:1	1.076	0.20 - 0.30
Md. 64 x Bu 21	BC	66	54	120	1:1	1.200	0.20 - 0.30
	F_2	120	30	150	3:1	2.000	0.10 - 0.20
Moore x Bu 21	BC	91	29	120	3:1	0.044	0.80 - 0.90
	F_2	145	5	150	15:1	2.174	0.10 - 0.20
Pooled X^2 *	BC	384	336	720	1:1	3.200	0.05 - 0.10
	F_2	707	192	899	3:1	6.363	0.01 - 0.02
Heterogeneity X^2 *	BC					8.532	0.05 - 0.10
	F_2					1.544	0.80 - 0.90

* Moore family not included in the pooled X^2 and heterogeneity X^2 calculations.

Gene Effects for Weather Fleck in *Nicotiana tabacum* L.

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Purpose and Objectives

Information on the mode of inheritance for tolerance to weather fleck in Maryland tobacco is needed. Significant general combining ability estimates from a series of intertype Maryland-cigar crosses (1) and intratype Maryland crosses (3), have suggested that additive genetic variance is more important in the tobacco populations than nonadditive genetic variance for weather fleck. The significance of specific combining ability at one location among Maryland tobacco crosses (3) indicated nonadditive effects may be important for certain crosses. Therefore, this study was undertaken in order to determine the relative importance of additive, dominance and epistatic gene effects for weather fleck in Maryland tobacco populations.

Procedures

The six genetic populations used in this study were derived by crossing seven Maryland tobacco varieties to Bel-W3, a cigar line highly susceptible to weather fleck. The seven Maryland varieties were Catterton, Md. 10, Wilson, Md. 59, Md. 609, Md. 64, and Md. 872. These varieties ranged from a moderate to a high level of tolerance to weather fleck. The F_1 generation from each cross was selfed and backcrossed to each parent. Therefore, for each cross, six generations were produced: P_1, P_2, F_1, F_2, P_1F_1, and P_2F_1. The six generations derived from a cross were considered as a family.

Each family was handled as a separate experiment and the six generations per family were grown in a randomized complete block design. In 1971 two families, Md. 59 and Md. 64, were grown at the Tobacco Experimental Farm, Upper Marlboro, Md. with six replications. In 1974 the number of families

was expanded to seven and each family was grown in a randomized complete block design with five replications. Each entry in each replication consisted of a single row plot containing 10 plants. Plant spacings between and within the plots were three and two feet, respectively.

Weather fleck ratings were made on five competitive plants in each plot when the plants were mature. Each plant received a score of one to five. A score of one indicated the plant was completely free of fleck symptoms and a score of five indicated severe flecking. Additive, dominance, and epistatic gene effects for weather fleck were determined from the generation means as outlined by Gamble (2).

In order to obtain phenotypic correlations of weather fleck with certain other plant traits, data also were collected on plant height, leaves per plant, internode length, and days to flower. Plant height and leaf count data were obtained from five competitive plants in each plot and days to flower data were obtained from eight competitive plants. Internode length data were determined by dividing plant heights by leaf counts.

Results

Mean weather fleck scores for the six generations by families are presented in Table 1. Considerable variation was observed among the seven Maryland tobacco varieties. Md. 872 was the most tolerant variety to weather fleck and Md. 59 was the most susceptible. Bel-W3 (P_2 column) was very susceptible to weather fleck with scores generally greater than 4.0. A heterotic response for the F_1 hybrids was observed and generally in the direction of tolerance.

Additive gene effects were significant for both families in 1971 and four out of seven families in 1974 (Table 2). Additive x dominance epistatic gene effects were significant for three families in 1974.

Phenotypic correlations for weather fleck with certain plant traits are shown in Table 3. Increased weather fleck scores were associated with taller plants, wider internodes and later flowering for the seven families. For three families lower leaf count was associated with a higher weather fleck score.

Summary

Generation mean analysis was used to determine the presence of additive, dominance, and epistatic gene effects for weather fleck in seven Maryland tobacco populations. Heterosis towards tolerance for weather fleck was observed in most populations. Additive gene effects appear to be most important in inheritance of weather fleck in most families. However, in three families epistatic effects were important. For these families adequate time should be allowed to break the epistatic interactions before selection pressure for weather fleck tolerance is applied to the populations. For the populations with mainly additive gene effects, the pure line approach should provide ample opportunity for increasing weather fleck tolerance.

During the development of plants tolerant to weather fleck, selection for plants with shorter statue and internode length would probably be helpful.

Acknowledgment

The computer time for the statistical analyses was made available through the facilities of the Computer Science Center of the University of Maryland.

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Table 1. Generation means for weather fleck ratings in six genetic populations.

Family	Generations					
	P_1	P_2	F_1	F_2	P_1F_1	P_2F_1
			1971			
Md. 59 x Bel-W3	2.17 [a/]	4.93	3.80	3.35	2.87	4.33
Md. 64 x Bel-W3	2.07	4.97	3.10	3.10	2.53	4.27
			1974			
Catterton x Bel-W3	2.24	4.36	2.80	2.76	2.60	2.52
Md. 10 x Bel-W3	1.84	4.60	2.44	2.76	2.24	2.56
Wilson x Bel-W3	1.48	4.12	2.04	2.16	1.68	2.76
Md. 59 x Bel-W3	2.32	4.32	2.80	2.64	2.84	3.24
Md. 609 x Bel-W3	1.52	4.28	2.36	2.40	2.00	3.40
Md. 64 x Bel-W3	1.44	4.08	2.04	2.24	1.64	2.80
Md. 872 x Bel-W3	1.32	3.76	1.48	1.68	1.32	2.24

[a/] 1.0 = no weather fleck symptoms, and 5.0 = severe fleck symptoms.

Table 2. Mean estimates of the six gene effects for the six crosses (families) for weather fleck.

Family	Gene effects 1/					
	m	a	d	aa	ad	dd
			1971			
Md. 59 x Bel-W3	3.35**	-1.46**	1.26	1.00	-0.08	-0.70
Md. 64 x Bel-W3	3.10**	-1.74**	0.78	1.20	-0.29	-1.56
			1974			
Catterton x Bel-W3	2.76**	0.08	-1.30	-0.80	1.14**	2.76
Md. 10 x Bel-W3	2.76**	-0.32	-2.22	-1.44	1.06**	3.16
Wilson x Bel-W3	2.16**	-1.08**	-0.52	0.24	0.24	0.56
Md. 59 x Bel-W3	2.64**	-0.40	1.44	1.96	0.60*	-1.52
Md. 609 x Bel-W3	2.40**	-1.40**	0.66	1.20	-0.02	-1.48
Md. 64 x Bel-W3	2.24**	-1.16**	-0.80	-0.08	0.16	0.80
Md. 872 x Bel-W3	1.68**	-0.92**	-0.66	0.40	0.30	0.52

1/ m = mean, a = additive, d = dominance, aa = additive x additive, ad = additive x dominance, and dd = dominance x dominance.

* Significant at the 5% level of probability.

** Significant at the 1% level of probability.

Table 3. Phenotypic correlations between weather fleck and certain agronomic traits, 1974.

Family	Plant height	Leaves per plant	Internode length	Days to flower
Catterton x Bel-W3	.54**	-.51**	.71**	.36**
Md. 10 x Bel-W3	.75**	-.19	.68**	.85**
Wilson x Bel-W3	.74**	-.70**	.85**	.61**
Md. 59 x Bel-W3	.72**	-.31	.76**	.71**
Md. 609 x Bel-W3	.69**	-.21	.83**	.36*
Md. 64 x Bel-W3	.75**	-.52**	.84**	.76**
Md. 872 x Bel-W3	.69**	-.01	.69**	.63**

* Significant at the 5% level of probability.
** Significant at the 1% level of probability.

Slow Release Nitrogen Source for Topdressing Small Grains

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Purpose and Objectives

Past experience demonstrates that of the approximately 350,000 acres of wheat, barley, rye and oats planted in Maryland each year, nearly 50% must be topdressed with from 20 to 100 lbs. of nitrogen per acre if top profits and maximum yields are to be realized. Research results have shown that for maximum utilization of readily available nitrogen sources, such as ammonium nitrate or urea, the nitrogen should be topdressed on the small grain at about the time the small grain starts to grow. In Maryland this period occurs usually during late February or early March. But a major problem with topdressing small grains at this time of year is that fields are often wet or in the process of thawing and are otherwise difficult or unsuitable for the operation of heavy farm equipment. Obviously, there would be a distinct advantage if a slow-release nitrogen fertilizer material could be applied in the fall of the year preferably at seeding time, thus eliminating the traditional spring topdressing.

Previous Maryland tests utilizing various forms of sulfur-coated urea at different dissolution rates as well as regular urea applied to small grains in the fall or topdressed in the spring, indicated that sulfur-coated urea was not satisfactory. This was true regardless of whether SCU was applied in the fall or in the spring or whether it was incorporated into the soil or topdressed on the surface. Maximum yields were obtained from the traditional spring topdressing of the soluble nitrogen source. Therefore the purpose of this test was to study the effects of various ratios of regular urea and sulfur-coated urea[a] (SCU_{30}) when disked-in in the fall at seeding or topdressed in the early spring.

Procedure

This test was conducted on a Galestown loamy sand soil at the Poplar Hill Research Farm near Salisbury, Maryland. Blueboy wheat was seeded in the fall of 1974. A split plot experimental design was utilized in which the main plots were time of application and the sub-plots consisted of various ratios of urea to sulfur-coated urea (SCU_{30}). The main plot treatments were: 1) nitrogen disked-in in the fall at seeding time and 2) nitrogen topdressed in the conventional manner in the spring. Nitrogen was applied at rates of 0 and 60 lbs. of N per acre. The sub-plots consisted of various ratios of nitrogen from urea and SCU_{30}. These ratios were in lbs/A of N: 1) 0 to 0; 2) 0 to 60; 3) 15 to 45; 4) 30 to 30; and 5) 60 to 0. Blueboy wheat was seeded in the fall of 1974 and grain yields were harvested in July, 1975.

Results

Visual observations early in the season left little doubt that Blueboy wheat was responding to the nitrogen treatments. Height measurements were taken on June 19, 1975 and the results presented in Table 1. Overall, the spring applied nitrogen resulted in taller plant height than the fall applied nitrogen. The ratio of urea to SCU_{30} in the fall had little effect on the height of the plant. The tallest plants were those which had been topdressed with 60 lbs/A of N as urea in the spring.

Similarly, grain yields followed about the same trend as vegetative growth (Table 2). Again, the spring applied nitrogen resulted in higher yields than the fall applied nitrogen. Of the fall applications, the treatments in which most of the nitrogen was as SCU_{30} seemed to produce higher yields than where all the nitrogen was urea. In the spring, maximum yields occurred where 100% of the nitrogen was supplied as regular urea.

Summary

It is obvious from this data that fall applied sulfur-coated urea or a mixture of fall applied sulfur-coated urea and fall applied urea will not produce wheat yields as high as those obtained from spring applied urea. The traditional early spring topdressing with a soluble nitrogen source still appears to be the best means of topdressing small grains.

Table 1. Height of Blueboy wheat on 6-19-75 following treatment with variable ratios of Urea and Sulfur-coated urea at 60 lbs/A N. 1975.

Time of Application	Urea:SCU$_{30}$ (60 lb N/A) 0:0	0:60	15:45	30:30	60:0	Ave.
	Inches					
Fall	26	29	29	26	28	28*
Spring	26	34	34	34	38	33
Ave.	26	31	32	30	33	

N LSD$_{.05}$ = 1 inch, Time x N LSD$_{.05}$ = 2 inches

* Significant at 5% level.

Table 2. Yield of Blueboy wheat following treatment with variable ratios of Urea and Sulfur-coated urea at 60 lbs/A N. 1975.

Time of Application	Urea:SCU_{30} (60 lb N/A) 0:0	0:60	15:45	30:30	60:0	Ave.
	Bu/A					
Fall	20.0	28.0	29.2	26.2	25.9	25.8*
Spring	18.3	35.2	34.7	31.8	38.3	31.7
Ave.	19.2	31.6	31.9	29.0	32.1	

$N\ LSD_{.05}$ = 3.4 Bu., Time x N $LSD_{.05}$ = 4.7 Bu.

* Significant at 5% level.

Nitrogen Topdressing of Arthur, Blueboy and Potomac Wheat

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Purpose and Objectives

Arthur and Blueboy are two wheat varieties that have been extremely popular in Maryland. However, Blueboy is rapidly being replaced by newer and better varieties. Some problems that have developed with Blueboy and have contributed to its loss of popularity include poor bushel weight, poor milling quality, and declining yields. Arthur is a very good variety, but is more subject to lodging than Blueboy, and does not have the high yield records that made Blueoby popular. A new variety recently released by the Virginia and Maryland Agricultural Experiment Stations, formerly designated as VA6654-6, but now named Potomac, looks very good. Since approximately 50% of the Arthur, Blueboy and Potomac wheat acreage in Maryland must be topdressed in the spring with from 20 to 100 lbs. of nitrogen per acre for maximum yields and top profits, this study was conducted to evaluate the effects of variable nitrogen topdressing rates on lodging, test weight, and grain yields.

Procedure

These tests were conducted on a Mattapex silt loam soil at the Poplar Hill Research Farm near Salisbury, a Bertie silt loam at the Wye Institute near Queenstown, and a Beltsville silt loam at the Plant Research Farm near Fairland. Arthur, Blueboy and Potomac wheat were established at these locations in the fall of 1974. Approximately 300 to 400 lbs. per acre of 5-20-20 fertilizer was applied at seeding time. The plots were topdressed in the early spring with an additional 0, 20, 40, 60,

80 or 100 lbs. of nitrogen per acre. During mid-June, observations were taken on resistance to lodging at the various nitrogen topdressing rates. Grain yield and bushel test weight was measured at maturity in July.

Results

Lodging ratings are given in Table 1. A rating of 1 indicated no lodging, 2 or 3 indicated intermediate degrees of lodging, and 4 indicated severe lodging. In previously conducted tests, Abe and Arthur wheat were both about equally susceptible to lodging. At high nitrogen levels, both varieties can lodge severely. In the 1975 tests, no lodging occurred at the Poplar Hill Farm or the Plant Research Farm regardless of the nitrogen rate. Some lodging did occur on the Bertie soil at Wye Institute at the high nitrogen rates. At the 100 lb. nitrogen rate, all varieties showed a slight degree of lodging. At the 80 lb. nitrogen rate, Potomac lodged slightly but no lodging was apparent in the Arthur or the Blueboy. In these tests, Potomac was slightly more susceptible to lodging than either Arthur or Blueboy.

Even though little lodging occurred in these tests, it would be folly to assume that there is little danger of lodging at high nitrogen rates by these varieties. Previous tests have indicated that Arthur and even Blueboy will lodge severely if the level of nitrogen in the soil is sufficiently high. Obviously, caution must be exercised when nitrogen topdressing these wheat varieties. It would appear that Potomac would lodge with slightly less nitrogen than Arthur.

Grain yields are presented in Table 2. There was no clear relationship between varieties since yields varied with location. However Potomac yielded the highest at all three locations. Arthur ranked second at the Plant Research Farm and was tied for second with Blueboy at the Poplar Hill Research Farm. Arthur yielded the lowest at Wye Institute.

Blueboy ranked second in yield at Wye Institute, was tied with Arthur for second at Poplar Hill, and ranked third at the Plant Research Farm.

Potomac wheat responded well to about 60 lbs. of nitrogen at 2 locations. At the Plant Research Farm maximum yields occurred at 100 lbs. of nitrogen per acre, but this may have been due to a very poor stand.

Blueboy yielded highest following 60 lbs. of nitrogen topdressed at the Poplar Hill Farm and 100 lbs. of nitrogen at Wye Institute. No response to more than 20 lbs. of nitrogen per acre occurred at the Plant Research Farm. Again, this may have been due to a very poor stand.

Arthur produced maximum yields with 80 lbs. of nitrogen per acre at all three locations.

Apparently, the new Potomac wheat should be topdressed with about the same nitrogen rates as Arthur for maximum yields.

Bushel test weight for the three varieties is given in Table 3. Test weights at the Plant Research Farm were abnormally low in 1975, apparently due to the poor stand and the high moisture content of the wheat at harvest time. Therefore, the 1975 data should be regarded only lightly. At Wye Institute and Poplar Hill, Potomac on the average had the best test weight. The test weight for Arthur and Potomac at Poplar Hill and Wye Institute was not influenced significantly by nitrogen rate. However the test weight for Blueboy declined significantly with increased nitrogen rates at both of these locations. This trend is typical for Blueboy and has been noted in previous tests.

Summary

In general, Arthur and Potomac wheat responded about equally well to nitrogen fertilization and were about equally susceptible to lodging at high nitrogen rates. Potomac was the highest yielding variety in these tests. Blueboy yielded the lowest. Potomac and Arthur were also

about equivalent in bushel test weight with Potomac wheat having a slightly heavier test weight. Blueboy had the lowest test weight.

These tests indicated that Arthur and Potomac wheat should be top-dressed with approximately the same nitrogen rates. This would range from approximately 20 to 80 lb/A of nitrogen, depending upon location, soil type, residual soil nitrogen level, etc.

Table 1. Lodging of Arthur, Blueboy and Potomac wheat at various nitrogen topdressing rates at three locations. 1975.

Variety	lb/A N						
	0	20	40	60	80	100	Ave.
	Lodging[1/]						
Poplar Hill Farm							
Arthur	1	1	1	1	1	1	1
Blueboy	1	1	1	1	1	1	1
Potomac	1	1	1	1	1	1	1
Ave.	1	1	1	1	1	1	
Wye Institute							
Arthur	1	1	1	1	1	2	1
Blueboy	1	1	1	1	1	2	1
Potomac	1	2	1	1	2	2	2
Ave.	1	1	1	1	1	2	
$LSD_{.05}$ N = 1, $LSD_{.05}$ Var. = 1							
Plant Research Farm							
Arthur	1	1	1	1	1	1	1
Blueboy	1	1	1	1	1	1	1
Potomac	1	1	1	1	1	1	1
Ave.	1	1	1	1	1	1	

1/ 1 = no lodging
2 = slight lodging
3 = moderate lodging
4 = severe lodging

Table 2. Yield of Arthur, Blueboy and Potomac wheat at various nitrogen topdressing rates at three locations. 1975.

Variety	lb/A N						
	0	20	40	60	80	100	Ave.
	Bu/A						
Poplar Hill Farm							
Arthur	32.7	36.6	46.9	47.0	53.4	52.8	44.9
Blueboy	35.3	42.7	47.0	50.6	45.8	47.9	44.9
Potomac	41.4	51.7	62.2	65.5	66.6	66.4	59.0
Ave.	36.5	43.7	52.0	54.4	55.3	55.7	
N $LSD_{.05}$ = 3.4 Bu, Var. $LSD_{.05}$ = 5.9 Bu, N x Var. $LSD_{.05}$ = 5.8 Bu							
Wye Institute							
Arthur	32.5	33.2	45.6	47.8	53.1	51.4	43.9
Blueboy	39.6	47.6	50.1	54.9	60.1	62.5	52.5
Potomac	50.7	63.2	61.3	69.7	69.1	69.7	63.9
Ave.	40.9	48.0	52.3	57.4	60.1	61.2	
N $LSD_{.05}$ = 5.4 Bu, Var. $LSD_{.05}$ = 4.1 Bu, N x Var. $LSD_{.05}$ = 9.3 Bu							
Plant Research Farm							
Arthur	27.0	33.6	28.8	30.3	41.6	37.0	33.0
Blueboy	19.2	29.5	21.7	25.2	26.1	25.4	24.5
Potomac	36.9	37.8	33.2	39.8	41.7	46.8	39.4
Ave.	27.7	33.6	27.9	31.8	36.4	36.4	
N $LSD_{.05}$ = 6.7 Bu, Var. $LSD_{.05}$ = 9.4 Bu, N x Var. $LSD_{.05}$ = 11.7 Bu							

Table 3. Bushel test weight of Arthur, Blueboy and Potomac wheat at various nitrogen topdressing rates at three locations. 1975.

Variety	lb/A N						
	0	20	40	60	80	100	Ave.
	lb/Bu						
Poplar Hill Farm							
Arthur	57.2	58.2	57.5	56.9	58.0	57.3	57.5
Blueboy	57.2	55.4	55.6	53.8	54.4	52.6	54.8
Potomac	58.3	56.6	59.5	58.0	57.6	55.7	57.6
Ave.	57.6	56.8	57.5	56.2	56.7	55.2	
$N\ LSD_{.05}$ = 1.2 lb, Var. $LSD_{.05}$ = 1.2 lb, N x Var. $LSD_{.05}$ = 2.1 lb							
Wye Institute							
Arthur	58.0	57.3	57.3	57.8	57.9	58.3	57.8
Blueboy	57.2	57.0	55.6	56.6	55.5	55.1	56.2
Potomac	59.8	60.2	60.3	59.3	59.3	59.7	59.8
Ave.	58.3	58.2	57.8	57.9	57.6	57.7	
$N\ LSD_{.05}$ = 0.4 lb, Var. $LSD_{.05}$ = 0.3 lb, N x Var. $LSD_{.05}$ = 0.7 lb							
Plant Research Farm							
Arthur	49.9	50.2	49.6	50.1	47.4	48.0	49.2
Blueboy	47.4	47.6	46.7	47.8	45.9	45.9	46.9
Potomac	52.1	52.1	52.7	52.4	53.1	50.3	52.1
Ave.	49.8	50.0	49.7	50.1	48.8	48.1	
$N\ LSD_{.05}$ = 1.4 lb, Var. $LSD_{.05}$ = 1.3 lb							

No-Tillage Corn Fertilization
I. Influence of Nitrogen Rate

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Purpose and Objectives

The purpose of this project was to study the effects of nitrogen fertilization rates on no-tillage corn as compared to conventional tillage corn. Obviously it is not possible with no-tillage to plow down the recommended rates of nitrogen, phosphorus and potassium fertilizers. Nor is it possible to incorporate recommended amounts of liming materials. Under the no-tillage concept, lime and fertilizer must be applied to the surface and cannot be incorporated deep into the plow layer. Field observations throughout Maryland have frequently indicated that no-tillage corn is apparently more nitrogen deficient when compared to conventional tillage corn under similar fertilization levels. The objective of this project was to compare no-tillage with conventionally tilled corn grown on well-drained soils under several rates of nitrogen fertilization.

Procedure

Tests were continued in the spring of 1975 at the Poplar Hill Research Farm near Salisbury, Wye Institute near Queenstown, Plant Research Farm near College Park, Forage Research Farm near Clarksville, and Maryland Correctional Institute Farm near Hagerstown. Soil types were Mattapex silt loam at Poplar Hill, Bertie silt loam at Wye Institute, Beltsville silt loam at Plant Research Farm, Delanco silt loam at Forage Research Farm, and Hagerstown silt loam at Maryland Correctional Institute.

With the exception of the Maryland Correctional Institute where no

cover crop was seeded, a rye cover crop was established at all other locations on the no-till plots in the fall of 1974. The cover was killed with a quart of paraquat and 1 pound per acre each of atrazine plus simazine the first week of May. No cover crop was grown on the conventional tillage plots. Pioneer 3369A field corn was planted on May 10, 1975 at Poplar Hill, May 14 at Plant Research Farm, May 22 at Wye Institute, and May 9 at the Forage Research Farm. Acco-Beachly-Hardy 9701F2 was planted at the Maryland Correctional Institute.

Phosphorus and potash were applied uniformly to all plots according to soil test recommendations. The nitrogen treatments were applied either prior to or immediately after planting. The treatments were as follows: No-tillage vs. conventional tillage and nitrogen at rates of 0, 40, 80, 120 and 160 lbs N/A in a split plot design. The main plots were the tillage treatments and the sub-plots were the nitrogen treatments. At Poplar Hill and the Forage Research Farm, the nitrogen source was ^{14}N-labeled ammonium sulfate. At the other locations, unlabeled ammonium nitrate was used.

Plots were observed frequently throughout the growing season and some nitrogen deficiency ratings were made as in previous years. Silage yields were harvested at Poplar Hill on August 22, at Wye Institute on August 26, and at the Forage Research Farm on August 28. As in previous years the silage harvest was accomplished by weighing six stalks at random from 2 of the rows. Stand counts were taken on each plot. The weight of six stalks, stand count, and the moisture content were utilized to compute the silage yields in tons per acre at 30% dry matter. The six stalks were passed through a small chopper. The chopped sample was thoroughly mixed and uniform sub-samples were removed for nitrogen analysis and moisture content.

Grain yields were harvested from all locations. Grain yields were

measured by hand harvesting a given length of row at all locations except Wye Institute where machine harvesting was utilized. A composite moisture sample was taken to convert yields to 15½% moisture.

Results

Grain yields were measured at all locations and are presented in Table 1. A significant response to nitrogen occurred at all locations. Maximum yields usually occurred at the highest nitrogen level. However, the response curve usually flattened out much sooner, normally after about 120 lbs. of nitrogen per acre. Exceptions occurred at the Forage Research Farm and the Maryland Correctional Institute where the curve flattened out after about 80 lbs. or 40 lbs. of nitrogen per acre respectively. Apparently at these locations relatively high levels of residual soil fertility were present. At 3 of the 5 locations grain yields were higher under conventional tillage than no-tillage. At the Plant Research and the Forage Research Farms, although not statistically significant, corn grain yields were higher on the no-tillage plots. At those locations where conventional tillage corn averaged higher yields than no-tillage, this was a result of wider differences at the lower nitrogen rates. When nitrogen levels were adequate, yields were generally the same for the two tillage systems. These 1975 observations are supported very closely by data from previous years. Where nitrogen was present at recommended levels, yields for the two tillage systems were equivalent, all other factors being equal.

It was noted that in some of those areas where no-tillage corn did not yield as well as conventional corn, some of the difference may have been the result of excessive soil moisture. Due to an abnormally high amount of rainfall in 1975, some of the test locations were often under water for a period of time. This flooding apparently restricted the no-till

more than the conventional corn. For instance, at the Maryland Correctional Institute a moisture deficit caused stress in 1974 for the conventional tillage corn. No such stress occurred in 1975. In 1974, the MCI no-tillage corn out-yielded the conventional corn. But in 1975 conventional out-performed no-tillage corn. Apparently, when soil moisture is deficient, no-tillage yields may be better than conventional yields. But, when soil moisture is excessive, the reverse may be true.

Silage yields at Poplar Hill, Wye Institute, and the Forage Research Farm were increased significantly by nitrogen (Table 2). At Poplar Hill and Wye Institute, conventionally tilled corn produced significantly more silage than the no-tillage corn. Highest silage yields occurred frequently following application of 160 lbs N/A, although again as with grain yields, the silage response curves tended to level off following approximately 80 to 120 lbs N/A.

Total nitrogen recovery (Table 3) was highest at Wye Institute and Poplar Hill following conventional tillage. No response due to tillage occurred at the Forage Research Farm. Increasing nitrogen rates significantly increased nitrogen recovery in the silage at all locations. The higher nitrogen recovery from the check plots at the Forage Farm reflected the higher residual soil N level at this location.

Weed control was a severe problem in the 1974 Poplar Hill nitrogen rate plots in which ^{14}N-labeled ammonium sulfate was used. Apparently, this lack of weed control was due to an extremely low pH developed in the surface layer of the soil by nitrification of the ammonium sulfate. Low soil pH is known to deactivate the triazine herbicides. Therefore, in 1975, soil samples were taken from 3 different depths on the N rate plots at Poplar Hill, the Plant Research Farm, and the Forage Research Farm (Table 4). The soil samples were taken after the nitrogen had been applied and the corn was growing.

At the 0 to 1 inch depth, 160 lbs. of nitrogen significantly reduced soil pH by as much as 1.5 pH units. For example, in the top inch at the Plant Research Farm, soil pH was lowered from 6.4 to 4.9. A soil sample from the 0 to 2 inch depth usually reflected the same pH level as a sample from the 0 to 1 inch depth. But, a soil sample from the 0 to 8 inch depth, although demonstrating a lowering of pH, did not indicate as great a reduction as occurred in the surface layer.

Soil samples from the nitrogen source tests at Poplar Hill (Tables 5 & 6) in which ammonium nitrate, urea, liquid nitrogen solution and broiler litter were being compared, did not reflect as great a reduction in pH as occurred on the ammonium sulfate plots. In the 0 to 1 inch layer, ammonium nitrate, urea, and 30% liquid nitrogen solution increased soil acidity by 0.2 to 0.6 pH units. Broiler litter did not lower soil pH.

As in past years, neither nitrogen recovery nor grain yield alone seemed to adequately reflect differences observed between the two tillage systems. Therefore linear regressions were calculated between nitrogen recovery and grain yields. The 1975 regressions from Poplar Hill are found in Figure 1. The regressions for the no-tillage and conventional tillage corn are almost identical to those from this location in 1973 and 1974. The differing slopes of these two regression lines indicate that at low yield levels where nitrogen is a limiting factor, grain yields will be higher from the conventional than from the no-tillage method. At higher yield levels where nitrogen is not limiting, grain yields for a given amount of recovered nitrogen are at least equivalent to and may be higher for no-tillage than for conventional tillage. Of course yields for any specific location and season were dependent on those numerous other factors which can limit plant growth.

Summary

1 - Under the variable soil and climatic conditions of these tests, at some locations the conventional tillage corn yielded higher than no-tillage. At other locations the reverse was true. Statistically grain yields were higher for conventional tillage at three of the five locations in 1975. Although yields were highest for no-tillage at the other 2 locations, the differences were not statistically significant.

2 - Available soil moisture apparently influences yields differently from the two tillage systems. Where moisture is deficient and is placing stress on the plants, the no-tillage system apparently produces greater yields than the conventional system. Where soil moisture is excessive, it is apparent that the no-tillage system produces lower yields than the conventional system. At normal soil moisture levels, it is doubtful that any yield differences will be detected between the two tillage systems.

3 - Nitrogen availability is more critical for no-tillage than for conventional tillage corn. Where available soil nitrogen levels were deficient, conventionally tilled corn produced higher yields than the no-tillage corn. But where soil nitrogen levels were adequate, there were very little yield differences between the two tillage systems.

4 - Previous research in other states has indicated that the triazine herbicides are inactivated by low soil pH. Equivalent quantities of N from ammonium sulfate, are many times more acid forming than the N from ammonium nitrate or urea. The use of ammonium nitrate and urea on no-tillage resulted in some depression of surface soil pH. A soil sample from the 0 to 2 inch depth accurately reflected surface soil pH, whereas a sample from the 0 to 8 inch depth did not. These tests indicated that if soil pH ranges from about 6.2 to 6.5 before nitrogen is applied, it is unlikely that any significant reduction in the activity of the triazines will occur.

But, if soil pH is below 6.2, weed control may become a serious problem if the triazines are being depended upon and an adequate liming program is not being carried out.

Table 1. Grain yield response of no-tillage and conventional tillage corn at various nitrogen rates at five locations. 1975.

Tillage	Applied N lb/A 0	40	80	120	160	Ave.
	Bu/A(15.5% H_2O)					
Poplar Hill						
No-Tillage	42.3	58.8	104.6	147.8	143.9	99.4*
Conventional	51.1	101.4	129.5	142.9	152.8	115.6
Ave.	46.7	80.1	117.0	145.4	148.4	
N $LSD_{.05}$ = 14.7 Bu, N x Tillage $LSD_{.05}$ = 20.8 Bu						
Wye Institute						
No-Tillage	57.7	73.6	98.8	107.2	130.4	93.6**
Conventional	60.5	114.8	129.2	137.2	129.6	114.3
Ave.	59.1	94.2	114.0	122.2	130.0	
N $LSD_{.05}$ = 14.5 Bu, N x Tillage $LSD_{.05}$ = 20.6 Bu						
Plant Research Farm						
No-Tillage	54.0	62.2	108.1	129.9	129.9	96.8
Conventional	35.3	62.0	106.6	120.0	134.1	91.6
Ave.	44.6	62.1	107.4	124.9	132.0	
N $LSD_{.05}$ = 13.3 Bu						
Forage Research Farm						
No-Tillage	127.3	131.6	164.1	165.6	170.2	151.8
Conventional	115.3	125.8	141.2	151.5	139.3	134.6
Ave.	121.3	128.7	152.7	158.6	154.7	
N $LSD_{.05}$ = 14.1 Bu						
Maryland Correctional Institute						
No-Tillage	91.6	129.6	131.9	132.0	141.7	125.4**
Conventional	115.5	142.1	138.8	152.0	164.9	142.6
Ave.	103.6	135.9	135.3	142.0	153.3	
N $LSD_{.05}$ = 19.3 Bu						

** Average for tillage significant at 5% level.
* Average for tillage significant at 10% level.

Table 2. Silage yield response of no-tillage and conventional tillage corn at various nitrogen rates at three locations. 1975.

Tillage	Applied N lb/A 0	40	80	120	160	Ave.
	Tons/A(30% D.M.)					
Poplar Hill						
No-Tillage	12.4	17.4	22.4	24.4	27.4	20.8**
Conventional	16.9	24.1	25.2	27.1	27.1	24.1
Ave.	14.7	20.8	23.8	25.8	27.2	
N $LSD_{.05}$ = 2.8 Tons						
Wye Institute						
No-Tillage	13.8	15.1	20.0	21.7	22.3	18.6**
Conventional	18.6	24.0	23.0	27.2	27.8	21.4
Ave.	16.2	19.5	21.5	24.4	25.1	
N $LSD_{.05}$ = 1.9 Tons						
Forage Research Farm						
No-Tillage	19.2	17.9	21.4	20.8	22.3	20.3
Conventional	17.3	17.5	19.6	20.9	22.4	19.5
Ave.	18.3	17.7	20.5	20.8	22.4	
N $LSD_{.05}$ = 0.9 Tons						

** Average for tillage significant at 5% level.

Table 3. Nitrogen recovery by no-tillage and conventional tillage corn at various nitrogen rates. 1975.

Tillage	Applied N lb/A					Ave.
	0	40	80	120	160	
	lb/A	lb/A	lb/A	lb/A	lb/A	lb/A
Poplar Hill						
No-Tillage	52.8	75.2	103.8	127.5	163.0	104.4**
Conventional	68.4	109.4	126.4	161.1	171.8	127.4
Ave.	60.6	92.3	115.1	144.3	167.4	
N $LSD_{.05}$ = 21.5 lb.						
Wye Institute						
No-Tillage	63.2	79.4	128.3	152.9	184.6	121.7**
Conventional	89.4	149.4	159.7	191.0	241.8	166.3
Ave.	76.3	114.4	144.0	172.0	213.2	
N $LSD_{.05}$ = 23.5 lb.						
Forage Research Farm						
No-Tillage	107.8	96.2	133.2	138.0	156.4	126.3
Conventional	104.9	95.6	121.8	137.2	162.2	124.3
Ave.	106.4	95.9	127.5	137.6	159.3	
N $LSD_{.05}$ = 14.3 lb.						

** Average for tillage significant at 5% level.

Table 4. Influence of several ammonium sulfate nitrogen rates on soil pH under no-tillage corn as indicated by three soil sampling depths. 1975.

Sample Depth (in.)	Applied N lb/A 0	40	80	120	160	Ave.
	pH	pH	pH	pH	pH	pH
Poplar Hill						
0-1	6.3	6.0	5.6	5.5	5.4	5.7
0-2	5.9	5.8	5.3	5.3	5.1	5.5
0-8	6.0	5.8	5.4	5.4	5.1	5.5
Ave.	6.0	5.8	5.4	5.4	5.2	
$N\ LSD_{.05} = 0.3$						
Plant Research Farm						
0-1	6.4	6.0	5.5	5.2	4.9	5.6
0-2	6.5	6.0	5.5	5.2	4.9	5.6
0-8	6.6	6.3	6.2	6.1	5.8	6.2
Ave.	6.5	6.1	5.7	5.5	5.2	
$Depth\ LSD_{.05} = 0.2$, $N\ LSD_{.05} = 0.2$, $N \times Depth\ LSD_{.05} = 0.3$						
Forage Research Farm						
0-1	6.3	5.8	5.3	4.8	4.9	5.4
0-2	6.4	5.9	5.4	5.1	4.9	5.5
0-8	6.5	6.4	6.2	5.8	5.9	6.2
Ave.	6.4	6.0	5.6	5.2	5.2	
$Depth\ LSD_{.05} = 0.2$, $N\ LSD_{.05} = 0.2$, $N \times Depth\ LSD_{.05} = 0.3$						

Note: Soil samples taken after N applied and corn planted.

Table 5. Influence of 120 lb/A nitrogen from three nitrogen sources on soil pH under no-tillage corn as indicated by three soil sampling depths. 1975.

Sample Depth (in.)	N Source: Check	Amm. Nitrate	Urea	30% N Sol.	Ave.
	pH	pH	pH	pH	pH
		Poplar Hill (#2)			
0-1	6.2	5.9	5.9	6.0	6.0
0-2	6.1	5.5	5.5	5.7	5.7
0-8	5.8	5.5	5.4	5.5	5.6
Ave.	6.0	5.6	5.6	5.7	

Depth $LSD_{.05}$ = 0.1, Source $LSD_{.05}$ = 0.2

Note: Soil samples taken after N applied and corn planted.

Table 6. Influence of 120 lb/A nitrogen from four nitrogen sources on soil pH under no-tillage corn as indicated by three soil sampling depths. 1975.

Sample Depth (in.)	N Source: Check	Amm. Nitrate	Urea (Reg)	Urea (TVA)	Broiler Litter	Ave.
	pH	pH	pH	pH	pH	pH
			Poplar Hill (#4)			
0-1	5.9	5.3	5.6	5.5	5.9	5.6
0-2	5.9	5.3	5.5	5.2	5.8	5.5
0-8	6.0	5.8	5.8	5.8	5.9	5.8
Ave.	6.0	5.4	5.6	5.5	5.9	

Depth $LSD_{.05}$ = 0.1, N $LSD_{.05}$ = 0.1, Depth x N $LSD_{.05}$ = 0.2

Note: Soil samples taken after N applied and corn planted.

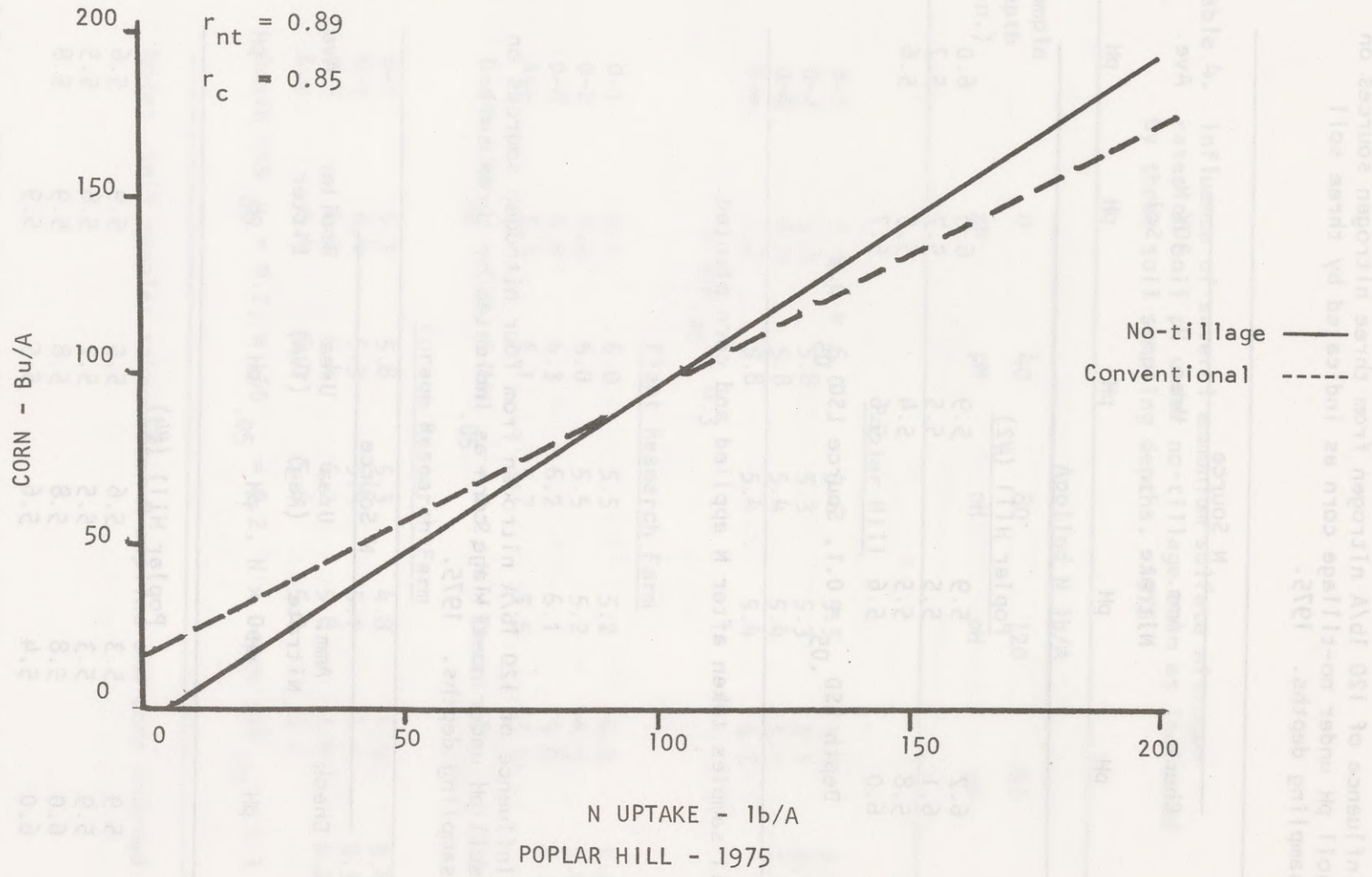

Figure 1. Relationship between grain yield and nitrogen recovery for two tillage systems at Poplar Hill. 1975.

No-Tillage Corn Fertilization
II. Influence of Nitrogen Source

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Purpose

The purpose of this project was to study the effects of several nitrogen sources on no-tillage as compared to conventional tillage corn. Obviously, with no-tillage corn it is not possible to plow down the recommended rates of nitrogen, phosphorus and potassium fertilizers. Nor is it possible to incorporate recommended amounts of liming materials. Under the no-tillage concept, lime and fertilizer must be applied to the surface and can not be incorporated deep into the plow layer. Field observations throughout Maryland have frequently indicated that some nitrogen sources do not perform as well when surface applied as compared to when they are incorporated into the soil. The objective of this project was to compare no-tillage with conventionally tilled corn grown on well-drained soils utilizing several different nitrogen sources.

Procedure

Tests were continued in the spring of 1975 on a Mattapex silt loam soil at the Poplar Hill Research Farm near Salisbury. A rye cover crop was established in the fall of 1974 and killed with a quart of paraquat and 1 lb. each of atrazine plus simazine per acre the first week of May. Pioneer 3369A field corn was planted on May 10, 1975.

Phosphorus and potash were applied uniformly to all plots according to soil test recommendations. The nitrogen treatments were applied either prior to or immediately after planting. The treatments were as follows: no-tillage vs. conventional tillage with nitrogen sources at 0 and 120 lbs. N per acre. Ammonium nitrate, regular prilled urea, TVA granulated urea,

30% liquid nitrogen solution, and broiler litter were applied at 120 lbs. N/A broadcast before planting. Also, in a separate treatment 120 lbs. N/A from 30% liquid nitrogen solution was sidedressed when the corn was approximately 18 inches tall. The experimental design was a split plot with the main plots being tillage treatment and the sub-plots being the nitrogen sources.

Silage yields were harvested on August 21, 1975. The silage harvest was accomplished by removing and weighing six stalks at random from two of the rows. Stand counts were taken on each plot. The weight of the six stalks, stand count, and moisture content were used to compute the silage yield in tons per acre at 30% dry matter. The six stalks were then passed through a small chopper. The chopped sample was thoroughly mixed and a uniform sub-sample was removed for nitrogen analysis and moisture content.

Grain yields were measured by harvesting by hand a given length of row. A composite moisture sample was taken to convert yields to 15½% moisture.

Results

As in previous years, grain yield differences again could be attributed to nitrogen source (Tables 1 & 2). In Test #2 at Poplar Hill (Table 1) which was being harvested for the third year, urea did not perform as well as ammonium nitrate or 30% liquid nitrogen solution broadcast. The 1975 results were somewhat different from the 1973 and 1974 data in that urea was inferior to ammonium nitrate and 30% liquid nitrogen solution under both tillage systems. In previous years, urea was equally as good as ammonium nitrate and the 30% liquid nitrogen solution under the conventional tillage system. But urea was inferior to the other sources under the no-tillage system. It is suggested that the data from this test should

be regarded with less confidence than that of 1973 and 1974, since two out of the four replications were lost due to an error in applying the fertility treatments. However, in a similar test (Test #4, Table 2), regular prilled urea and TVA granulated urea, were compared to ammonium nitrate and broiler litter. In this comparison, under conventional tillage, urea resulted in yields equivalent to the ammonium nitrate. But urea was definitely inferior to ammonium nitrate under no-tillage. The TVA granulated urea apparently resulted in lower grain yields than regular prilled urea (not statistically significant). The apparently higher nitrogen volatilization losses from the TVA granulated urea may have been a result of the larger granule size which concentrated more urea over a smaller soil area. It is well known that when urea is applied to the surface and not incorporated into the soil there is considerable danger of nitrogen volatilization losses.

In this series of nitrogen source tests conducted during 1973, '74 and '75, the data indicates that in three out of the four tests, urea performed more poorly than the other nitrogen sources under the no-tillage system. But urea was generally equivalent to other nitrogen sources under the conventional tillage system.

In another test in which ammonium nitrate and urea were compared with broiler litter as N source (Table 2), the broiler litter produced significantly lower yields than the other nitrogen sources, under both tillage systems. The lowest yields from broiler litter were obtained under the no-tillage system. Apparently, broiler litter behaves somewhat similarly to urea under the no-tillage system when there is a much greater danger of nitrogen volatilization losses than under the conventional tillage system where the manure has been incorporated into the soil.

In 1975, the 30% liquid nitrogen solution performed about equally

well as ammonium nitrate regardless of the time of application. Liquid nitrogen was superior to urea (Table 1). In previous years, liquid N solution rated between ammonium nitrate and urea.

Nitrogen source had a significant affect on silage yields (Table 3). Using urea rather than ammonium nitrate or 30% liquid nitrogen solution resulted in significantly lower silage yields under the no-tillage system. Yields apparently were not reduced as much under the conventional tillage system due to urea. Liquid nitrogen solution performed about equally well to the ammonium nitrate and superior to urea under no-tillage. It did not perform quite as well as urea or ammonium nitrate under the conventional tillage system. But differences between urea and liquid nitrogen solution was not statistically significant under conventional tillage.

In Test #4 (Table 4) in which ammonium nitrate, regular prilled urea, TVA granulated urea, and broiler litter were compared, silage yields again were slightly lower from the urea than from the ammonium nitrate under no-tillage. But under conventional tillage all three chemical fertilizers were about equal. The broiler litter produced significantly less silage than the other three nitrogen sources, even though applied at an equivalent rate of nitrogen. Yields were lowest where broiler litter was applied to no-tillage corn. Broiler litter was apparently utilized most efficiently on conventional tillage corn.

In Test #2 (Table 5), the corn recovered less nitrogen from urea than from the other nitrogen sources under no-tillage. However, in Test #4 (Table 6) the regular prilled urea resulted in about the same amount of nitrogen being recovered as the ammonium nitrate. TVA granulated urea accounted for the highest amount of nitrogen recovered. The apparently acceptable performance of the two urea materials in this particular test may have been a reflection of a relatively high soil N level since this

test was in it's first year. Broiler litter resulted in the lowest amount of nitrogen being recovered in the corn silage.

Summary

Some variability occurred in the response of corn under the two tillage systems and the various nitrogen sources. But in general, under no-tillage, corn yields were not as high from urea as from ammonium nitrate. Liquid nitrogen solution performed better than urea under no-tillage. For conventional tillage corn, all nitrogen sources, with the exception of broiler litter, resulted in equivalent yields. Broiler litter did not produce yields as high as the other nitrogen sources under either tillage system. The lowest nitrogen recovery was obtained from broiler litter when applied to no-tillage corn.

Table 1. Grain yield response of no-tillage and conventional tillage corn following application of 120 lb N/A from three sources. 1975.

Tillage	N Source					Ave.
	Check	Amm. Nitrate [1/]	Urea [1/]	30% N Sol. [1/]	30% N Sol. [2/]	
	Bu/A (15.5% H_2O)					
Poplar Hill (#2)						
No-Tillage	36.7	121.6	104.0	121.2	121.2	101.0**
Conventional	61.8	162.0	147.4	161.2	150.4	136.6
Ave.	49.2	141.8	125.8	141.2	135.8	

Source $LSD_{.05}$ = 15.0 Bu

** Average for tillage significant at 5% level.
1/ Broadcast pre-plant.
2/ Sidedressed when 18 inches tall.

Table 2. Grain yield response of no-tillage and conventional tillage corn following application of 120 lb N/A from four sources. 1975.

Tillage	N Source					Ave.
	Check	Amm. Nitrate	Urea (reg)	Urea (TVA)	Broiler Litter	
	Bu/A (15.5% H_2O)					
Poplar Hill (#4)						
No-Tillage	65.8	170.3	152.0	139.3	119.4	129.4
Conventional	106.3	170.9	162.2	168.6	142.6	150.1
Ave.	86.1	170.6	157.1	154.0	131.0	

Source $LSD_{.05}$ = 16.7 Bu

Table 3. Silage yield response of no-tillage and conventional tillage corn following application of 120 lb N/A from three sources. 1975.

Tillage	N Source: Check	Amm. Nitrate 1/	Urea 1/	30% N Sol. 1/	30% N Sol. 2/	Ave.
	Tons/A (30% D.M.)					
			Poplar Hill (#2)			
No-Tillage	9.0	19.8	16.0	20.7	18.5	16.8**
Conventional	14.6	26.4	24.6	22.4	21.2	21.8
Ave.	11.8	23.1	20.3	21.6	19.8	

Source $LSD_{.05}$ = 3.5 Tons

** Average for tillage significant at 5% level.
1/ Broadcast pre-plant.
2/ Sidedressed when 18 inches tall.

Table 4. Silage yield response of no-tillage and conventional tillage corn following application of 120 lb N/A from four sources. 1975.

Tillage	N Source: Check	Amm. Nitrate	Urea (Reg)	Urea (TVA)	Broiler Litter	Ave.
	Tons/A (30% D.M.)					
			Poplar Hill (#4)			
No-Tillage	16.6	24.8	21.6	23.4	20.2	21.3*
Conventional	19.5	27.9	29.2	28.0	25.0	25.9
Ave.	18.0	26.4	25.4	25.7	22.6	

Source $LSD_{.05}$ = 3.0 Tons

* Average for tillage significant at 10% level.
** Average for tillage significant at 5% level.

Table 5. Nitrogen recovery by no-tillage and conventional tillage corn following application of 120 lb N/A from three sources. 1975.

Tillage	N Source					
	Check	Amm. Nitrate [1/]	Urea [1/]	30% N Sol. [1/]	30% N Sol. [2/]	Ave.
	lb/A	lb/A	lb/A	lb/A	lb/A	lb/A
			Poplar Hill (#2)			
No-Tillage	37.8	112.6	96.2	124.4	122.0	98.6
Conventional	59.0	182.0	156.2	137.2	161.0	139.1
Ave.	48.4	147.4	126.2	130.8	141.5	

Source $LSD_{.05}$ = 54.6 lbs.

1/ Broadcast pre-plant.
2/ Sidedressed when 18 inches tall.

Table 6. Nitrogen recovery by no-tillage and conventional tillage corn following application of 120 lb N/A from four sources. 1975.

Tillage	N Source					
	Check	Amm. Nitrate	Urea (Reg)	Urea (TVA)	Broiler Litter	Ave.
	lb/A	lb/A	lb/A	lb/A	lb/A	lb/A
			Poplar Hill (#4)			
No-Tillage	74.0	121.0	126.5	141.5	99.5	112.5**
Conventional	73.5	186.5	177.4	205.6	133.8	155.4
Ave.	73.8	153.8	151.9	173.6	116.6	

Source $LSD_{.05}$ = 36.7 lbs.

** Average for tillage significant at 5% level.

No-Tillage Corn Fertilization
III. Influence of Time of Nitrogen Application

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Purpose and Objectives

The purpose of this project was to study the effects of several times of application of nitrogen on no-tillage as compared to conventional tillage corn. Obviously, with no-tillage corn, it is not possible to plow down recommended rates of fertilizer. Nor is it possible to incorporate recommended amounts of liming materials. Under the no-tillage concept, lime and fertilizer must be applied to the surface and cannot be incorporated deep into the plow layer. Field observations throughout Maryland have frequently indicated no-tillage corn to be more nitrogen deficient than conventionally tilled corn at similar fertilization rates. The purpose of this project was to compare no-tillage with conventionally tilled corn utilizing single and split nitrogen applications as well as to also observe the influence of variable dates of nitrogen application on the cover crop.

Procedure

Tests on single and split nitrogen applications were continued in the spring of 1975 at the Poplar Hill Research Farm near Salisbury on a Mattapex silt loam soil. A rye cover crop established in the fall of 1974 on the no-till areas was killed with a quart of paraquat and 1 lb/A each of atrazine plus simazine the last week of April. Pioneer 3369A field corn was planted on May 10, 1975. Phosphorus and potash were applied uniformly to all plots according to soil test recommendations.

The nitrogen treatments were applied either prior to or immediately after planting. The treatments were as follows: No-tillage vs. conventional

tillage corn with ammonium nitrate at rates of 0 and 120 lbs. N/A. The nitrogen treatments were 1) 120 lbs. N/A broadcast and none sidedressed, 2) 60 lbs. N/A broadcast and 60 sidedressed, 3) 30 lbs. N/A broadcast and 90 sidedressed, 4) none broadcast and 120 lbs. N/A sidedressed. The experimental design was a split plot with the main plots consisting of the tillage treatments and the sub-plots consisting of the nitrogen treatments.

In a separate test, no-tillage corn was grown after ammonium nitrate had been applied at 120 lbs. N/A to the cover crop at various dates in the spring. Application dates were: 1) March 12; 2) March 26; 3) April 9; 4) April 23; and 5) split - half applied on March 12 and half applied on April 23. The cover was killed with paraquat on April 23.

Silage yields were harvested from both tests on August 21, 1975. The silage harvest was accomplished by removing and weighing six stalks at random from two of the corn rows. Stand counts were taken on each plot. The weight of the six stalks, the stand count, and the moisture content were utilized to compute the silage yield in tons/A at 30% dry matter. The six stalks were passed through a small chopper. The chopped sample was thoroughly mixed and a uniform sub-sample was removed for nitrogen analysis and moisture content. Grain yields were measured by hand harvesting a given length of row. A composite moisture sample was taken in order to convert yields to 15½% moisture.

Results

Split nitrogen applications after the cover crop had been killed had no significant effect on grain yields (Table 1). It made no difference whether the nitrogen was all broadcast, part broadcast and part sidedressed, or all sidedressed. The 120 lbs. of nitrogen per acre resulted in approximately 100 bushels per acre yield increase over the no-nitrogen check plots. Conventional tillage was better than no-tillage, in this case due perhaps to excessive soil moisture.

In a new test (Test #5, Table 2), it was determined that the time of application of nitrogen on the rye cover crop can have a critical effect on corn yields. The earlier in the season that the nitrogen is applied, the more time the cover crop has to utilize this nitrogen rather than leave it available for the corn. Nitrogen applied to the cover crop too early can significantly reduce corn yields. Maximum yields and maximum nitrogen recovery occurred following the later nitrogen application dates. It was apparent that nitrogen taken up by the rye cover crop is not available to the succeeding corn crop, at least not during the application year.

In Table 3, single and split nitrogen applications were examined. Silage yields were increased significantly by 120 lbs. of nitrogen per acre. Conventional tillage out-yielded no-tillage corn. However, there was no yield difference due to broadcast or sidedressed application. Silage yields were similar regardless of whether the nitrogen was all broadcast before planting, split (part broadcast before planting and part sidedressed after the corn was growing), or all sidedressed. Single and split nitrogen applications had no significant effect upon total nitrogen recovery (Table 4). The nitrogen recovery response was similar to that found for grain and silage yields.

Summary

1 - On medium textured soils, both tillage systems responded equally well to single or split nitrogen applications from ammonium nitrate. It made little difference whether the ammonium nitrate was applied in a single broadcast application, in a single sidedress application, or was split between broadcast and sidedress.

2 - When nitrogen was applied too early in the spring, while the cover crop was still actively growing, a significant portion of that

nitrogen was not available to the corn crop and yields were reduced. For maximum yields from no-tillage corn, it is important that the rye cover crop be killed soon after the nitrogen is applied. This practice minimizes the amount of nitrogen tied up by the cover crop and thus made unavailable to the corn. For maximum nitrogen efficiency, it was obviously necessary to apply N fertilizers as close as possible to the time the corn plant needs the nitrogen.

Table 1. Grain yield response of no-tillage and conventional tillage corn following single and split applications of 120 lb N/A. 1975.

Tillage	N(lb/A) Broadcast and/or Sidedressed					
	Check	120 Br. 0 S.D.	60 Br. 60 S.D.	30 Br. 90 S.D.	0 Br. 120 S.D.	Ave.
	Bu/A (15.5% H_2O)					
Poplar Hill						
No-Tillage	38.2	129.1	133.8	135.3	129.3	113.1**
Conventional	48.6	158.6	166.9	159.0	154.9	137.6
Ave.	43.4	143.9	150.3	147.2	142.1	

Placement $LSD_{.05}$ = 11.2 Bu

** Average for tillage significant at 5% level.

Table 2. Grain and silage yield and nitrogen recovery of no-tillage corn following application of 120 lb N/A on the rye cover crop at variable time differences before the rye was killed on 4/23. 1975.

	Date of Application					
	Check	3/12 & 4/23	3/12	3/26	4/9	4/23	$LSD_{.05}$
Poplar Hill							
Bu/A(15.5% H_2O)	60.8	100.1	110.7	121.6	141.5	148.6	24.5
Tons/A(30% D.M.)	13.6	19.6	20.1	21.2	22.4	25.1	4.1
N Recovery(lb/A)	59.7	109.2	103.4	112.8	123.9	155.3	35.8

1/ 60 lb/A Br. 3/12/75
60 lb/A Br. 4/23/75

Table 3. Silage yield response of no-tillage and conventional tillage corn following single and split application of 120 lb N/A. 1975.

Tillage	N(lb/A) Broadcast and/or Sidedressed					
	Check	120 Br. 0 S.D.	60 Br. 60 S.D.	30 Br. 90 S.D.	0 Br. 120 S.D.	Ave.
	Tons/A (30% D.M.)					
Poplar Hill						
No-Tillage	10.5	23.0	20.9	20.6	23.2	19.6**
Conventional	16.2	24.5	22.1	23.6	25.5	22.4
Ave.	13.4	23.8	21.5	22.1	24.3	

Placement $LSD_{.05}$ = 2.4 Tons

** Average for tillage significant at 5% level.

Table 4. Nitrogen recovery by no-tillage and conventional tillage corn following single and split applications of 120 lb N/A. 1975.

Tillage	N(lb/A) Broadcast and/or Sidedressed					
	Check	120 Br. 0 S.D.	60 Br. 60 S.D.	30 Br. 90 S.D.	0 Br. 120 S.D.	Ave.
	lb/A	lb/A	lb/A	lb/A	lb/A	lb/A
Poplar Hill						
No-Tillage	50.8	142.7	137.3	142.2	159.1	126.4
Conventional	71.3	172.6	195.2	181.5	187.5	161.6
Ave.	61.1	157.6	166.2	161.9	173.3	

Placement $LSD_{.05}$ = 34.0 lbs.

Johnsongrass Control with Trifluralin and EPTC + R-25788

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Purpose and Objectives

The relative effectiveness of Trifluralin and EPTC + R-25788 for johnsongrass control is not well defined. Three identical field experiments were initiated at three different sites in Maryland to compare these herbicides for johnsongrass control.

Procedure

Three experimental sites were located at the Plant Research Farm, Poplar Hill Farm and Forage Farm on a Beltsville silt loam, Galestown loamy sand and Manor loam, respectively. Plots were 10 by 30 feet with 30 inch row spacing and were replicated 3 or 4 times in a randomized complete block design. Herbicides were applied at 30 gallons per acre and immediately incorporated to a depth of three inches with a rototiller. On the same day corn (DeKalb cultivar XL-43) or soybeans (cultivar Williams) were planted in appropriate plots (Table 1). Visual ratings were recorded throughout the growth period, and yields were recorded from 16 feet of the two center rows.

Results

Visual estimates of johnsongrass control taken in mid July indicated that EPTC + R-25788 (Figure 1) was more effective than trifluralin (Figure 2). It appeared that 6.7 kg/ha was the best application rate of EPTC + R-25788 (Figure 1) since increasing the rate did not appreciable improve control. Trifluralin (Figure 1) control of johnsongrass was not satisfactory at any rate and trifluralin was not significantly better than the weedy control at any of the three sites and did not improve when the rates increased. At the Poplar Hill site with sandy soil, trifluralin would be expected to be more effective

than at the other sites. Johnsongrass control with trifluralin was, however, uniformly poor at all three sites.

Crop injury at higher than normal rates has been reported to be a problem with both trifluralin and EPTC + R-25788. In these studies no injury symptoms were noted except for one plot in one replication at Poplar Hill with trifluralin at the 1.7 kg/ha rate and one plot in one replication at the Forage Farm with EPTC + R-25788 at the 10.1 kg/ha rate.

Yield of seed (Table 1) also indicated that EPTC + R-25788 controlled johnsongrass better than trifluralin. There were no significant differences in seed yield as a result of trifluralin application at any location, whereas, EPTC + R-25788 increased yield at all three locations.

Summary

Trifluralin and EPTC + R-25788 were evaluated for johnsongrass control at three locations. Control with EPTC + R-25788 was approximately 80%, whereas, trifluralin did not significantly increase control. EPTC + R-25788 increased corn yields almost to the weeded control, however, there were no significant increases in soybean yields caused by trifluralin application.

Table 1. Yield of Corn and Soybeans following variable rates of EPTC + R-25788 or Trifluralin, 1975.

Treatment	Rate (kg/ha)	Crop	Yield (bu/A)
Control (weeded)	---	Corn	64.4
Control	---	Corn	14.9
EPTC + R-25788	3.3	Corn	25.6
EPTC + R-25788	6.7	Corn	40.6
EPTC + R-25788	10.1	Corn	46.3
Control (weeded)	---	Soybeans	27.5
Control	---	Soybeans	7.8
Trifluralin	0.56	Soybeans	8.6
Trifluralin	1.1	Soybeans	8.7
Trifluralin	1.7	Soybeans	5.3

Figure 1. The influence of EPTC + R-25788 on johnsongrass control in corn.

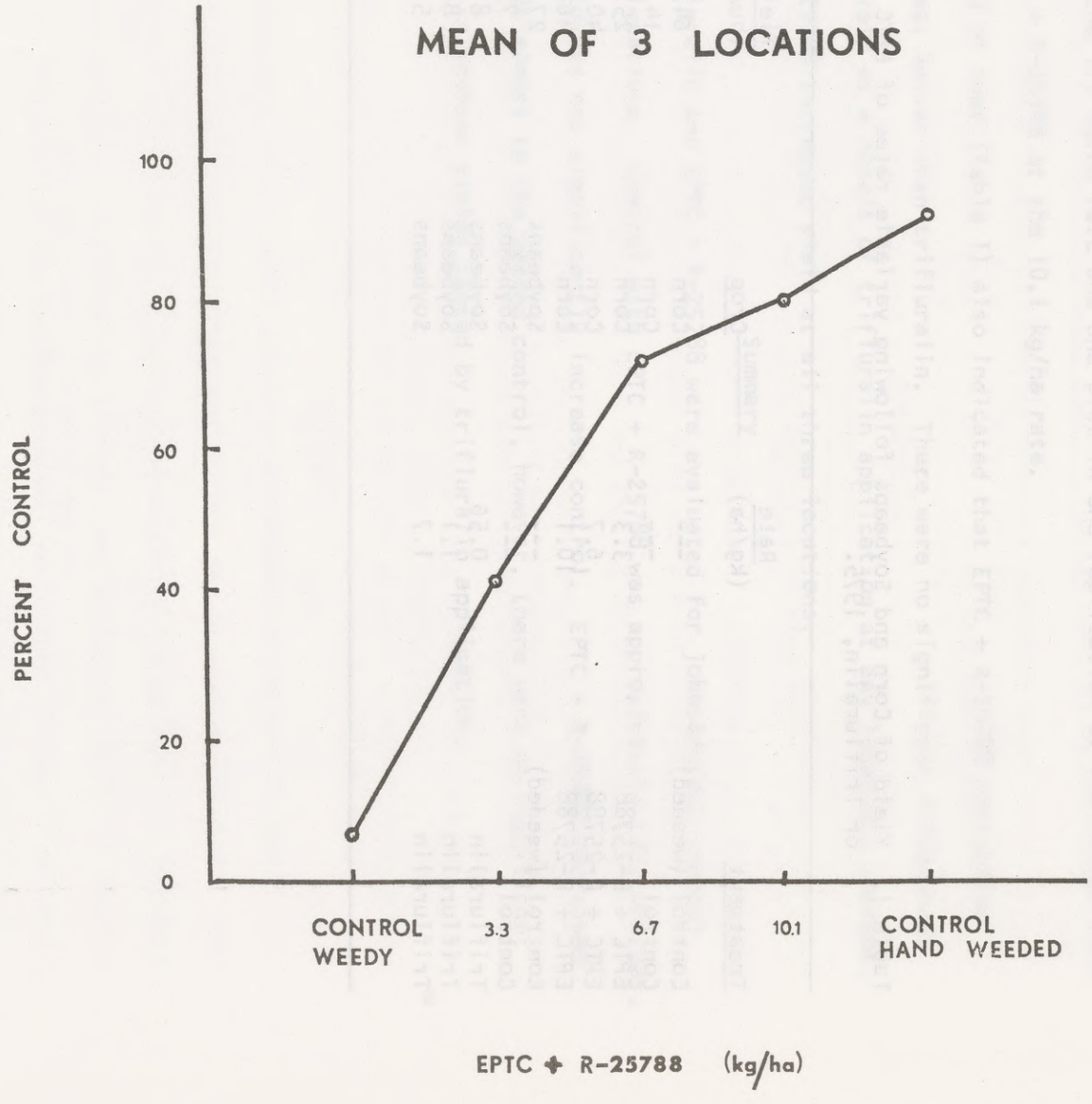
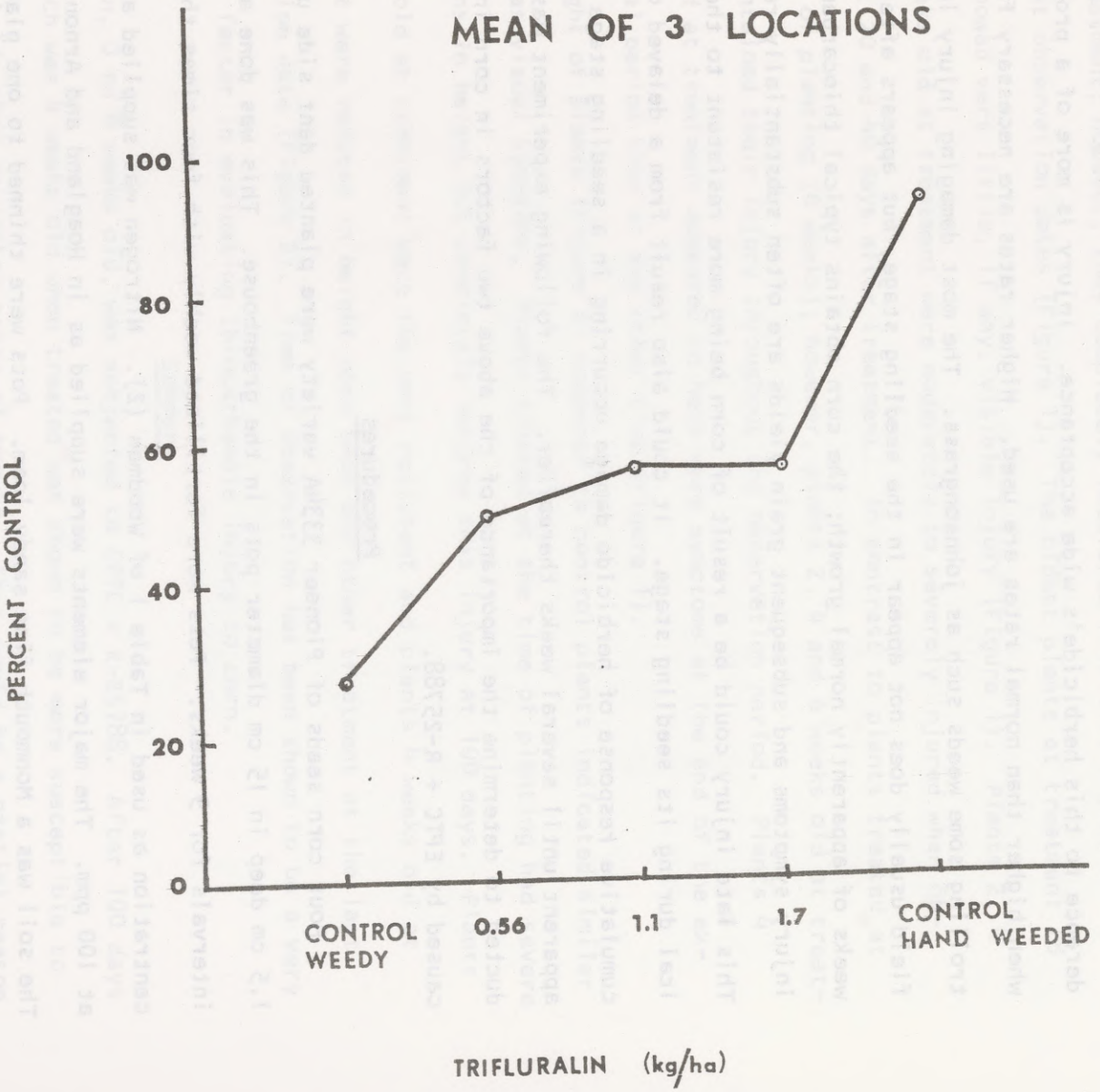


Figure 2. The influence of trifluralin on johnsongrass control in soybeans.



The Effect of Corn Age on Susceptibility to EPTC + R-25788

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Purpose and Objectives

Occasional injury to corn caused by EPTC + R-25788 is a significant hinderance to this herbicide's wide acceptance. Injury is more of a problem when higher than normal rates are used. Higher rates are necessary for controlling some weeds such as johnsongrass. The most damaging injury in the field usually does not appear in the seedling stage, but appears after several weeks of apparently normal growth; the corn obtains typical thiocarbamate injury symptoms and subsequent grain yields are often substantially reduced. This late injury could be a result of corn being more resistant to the chemical during its seedling stage. It could also result from a delayed or accumulative response of herbicide damage occurring in a seedling stage but not apparent until several weeks thereafter. The following experiment was conducted to determine the importance of the above two factors in corn injury caused by EPTC + R-25788.

Procedures

Four corn seeds of Pioneer 3334A variety were planted dent side up at 1.5 cm deep in 15 cm diameter pots in the greenhouse. This was done at weekly intervals for 9 weeks. Pots were fertilized weekly with four times the concentration as used in Table 1 of Woodman (2). Nitrogen was supplied as $NaNO_3$ at 100 ppm. The major elements were supplied as in Hoagland and Arnon (1). The soil was a Monmouth fine sandy loam. Pots were thinned to one plant after emergence. They were treated with 25 and 35 ppm of EPTC + R-25788 (12:1 w/w) when the final planting occurred. Visual injury symptoms and the height of the tallest extended leaf was recorded periodically after herbicide application.

There were three replications in a randomized block design.

Results

EPTC + R-25788 injured all treated plants at the rates used in this study, however, death did not occur. Corn treated at the time of planting (Figure 1) had more injury than other plants when observed at 20 and 40 days after treatment; however, they completely recovered from this injury at subsequent observation dates (Figure 1). The oldest plants at treatment (8 weeks) showed very little, if any, visible injury (Figure 1). Plants 2, 4 and 6 weeks old at treatment were moderately to severely injured when observed at 20 and 40 days after treatment. In contrast to plants treated at the time of planting (0 weeks); however, plants 2, 4 and 6 weeks old at treatment maintained their injury throughout the observation period. Plants 4 weeks old at treatment appeared to have more symptoms at the end of the experimental period than at any other time (Figure 1).

Height of plants (Figure 2) compared to control plants indicated similar results as visual symptoms. Plants treated at the time of planting had severe reductions in height but completely outgrew this injury at 100 days. Plants 8 weeks old at treatment were the most resistant and plants 4 weeks old at treatment were reduced in height more than any other treatment at the last observation date (Figure 2). Time of observation has been shown to be a very critical factor in evaluating thiocarbamate injury to corn.

Summary

Corn, 0 to 8 weeks old, was subjected to EPTC + R-25788. After 100 days corn which was 4 weeks old when treated was shown to be more susceptible to the herbicide than any other stage of growth. This could be a partial reason for the delayed thiocarbamate injury observed in the field.

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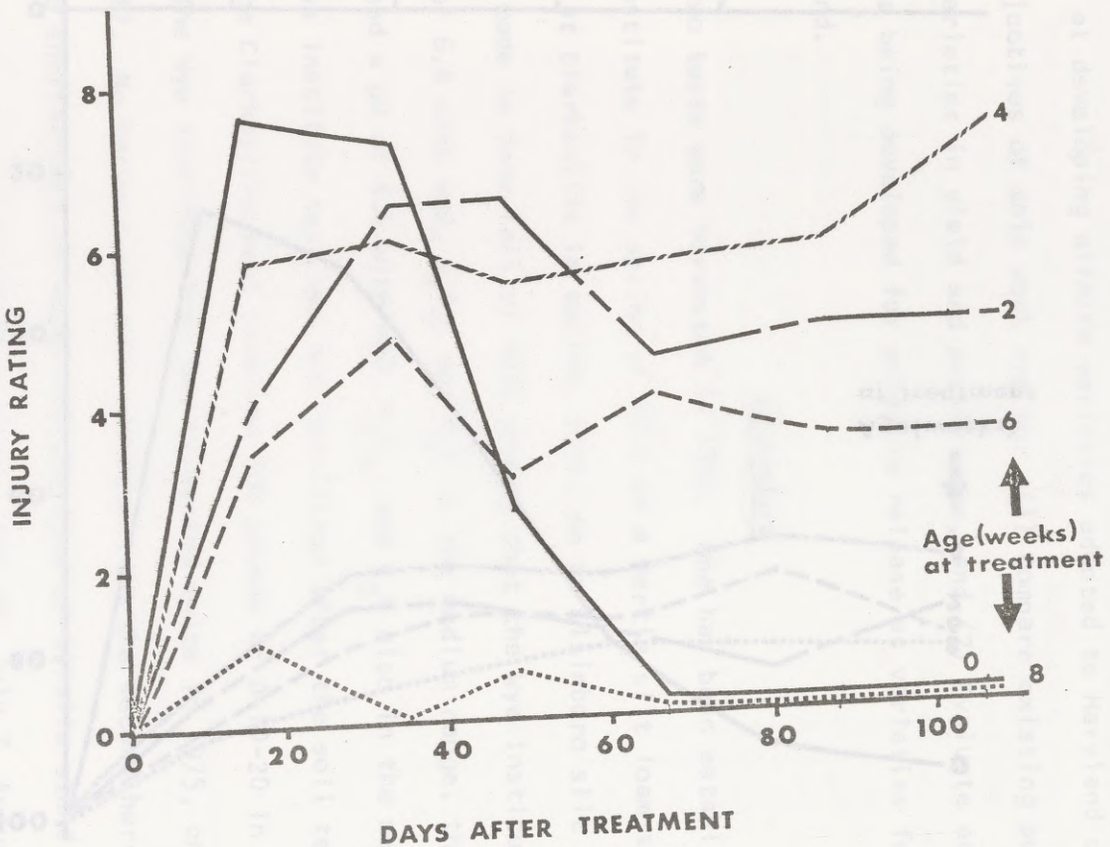
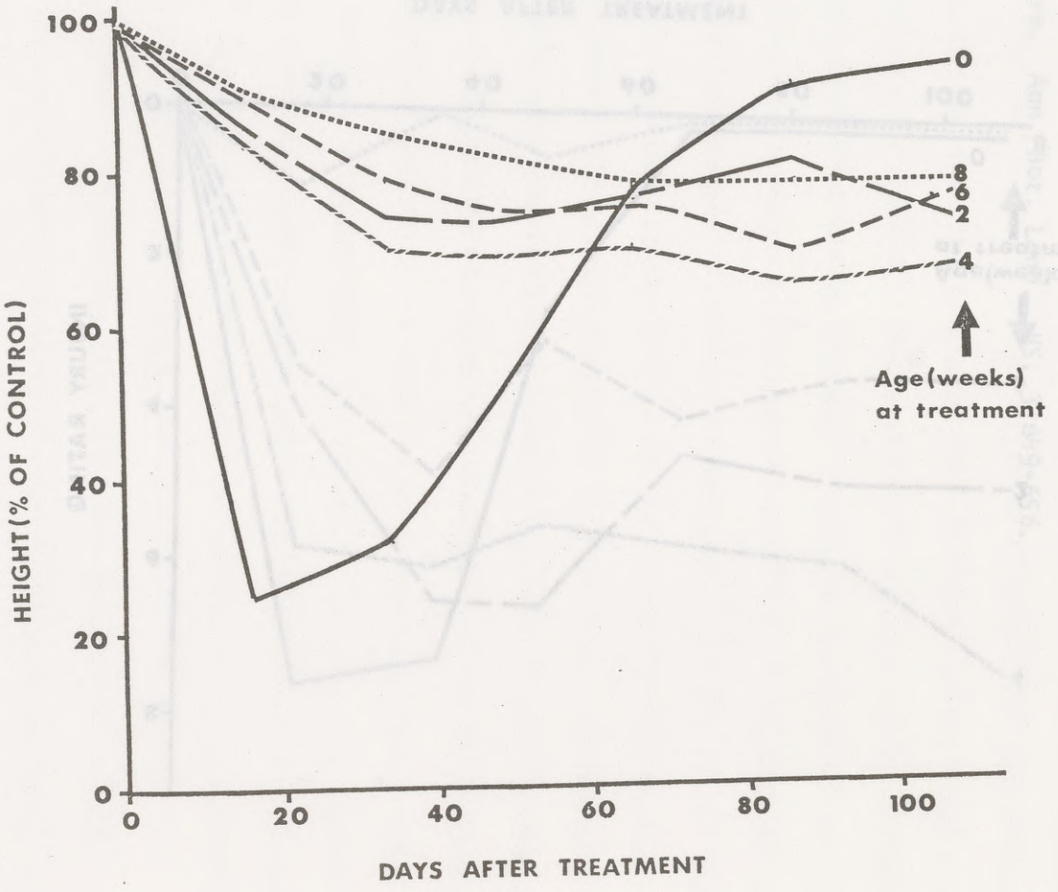


Figure 1. Visual ratings of EPTC + R-25788 injury as affected by plant age. 0= no visible injury, 10= death.

Figure 2. The effect of plant age on EPTC + R-25788 reduction in corn height.



Alfalfa Variety and Strain Tests

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Purpose and Objectives

Considerable effort in public and private breeding programs is directed at developing alfalfa varieties adapted to Maryland conditions. The objectives of this work are to: (1) Compare existing public and private varieties in yield and persistence, and (2) Evaluate advanced strains being developed for possible release as varieties for use in Maryland.

Procedure

Two tests were harvested in 1975. One had been established at the Wye Institute in the spring of 1970 on a Bertie silt loam soil, and the other at Clarksville in spring, 1971, on an Elsinboro silt loam. Soil tests made in late fall of 1974 showed that the Wye Institute soil had a pH of 6.6 with MgO, P_2O_5, and K_2O in the medium range; the Clarksville soil had a pH of 6.4 with MgO, P_2O_5, and K_2O also in the medium range. The Wye Institute test was not fertilized after the soil test was made, but the Clarksville test received 800 pounds of 0-10-20 in November, 1974.

The Wye Institute test was harvested twice in 1975, on May 27 and July 17. No harvest was made subsequent to the second harvest because of the encroachment of weeds and the loss of alfalfa stand. The Clarksville test was harvested four times: May 30, July 7, August 21 and October 14.

Results

Dry matter yields for the two tests are shown in Tables 1 and 2.

Entries are ranked in the tables according to yield from highest to lowest. Both these stands are old and considerable loss of plants has occurred. As a result, yields are low.

Summary

Two old alfalfa strain and variety tests which had been established in 1970 and 1971, were harvested in 1975. The stands were thin and yields were low. The results show, however, that yields from 4.5 to 5.0 tons per acre can be obtained from the better varieties after four years of production.

Table 1. 1975 dry matter yields from four harvests -- 1971 alfalfa strain and variety test at Clarksville, Maryland

Alfalfa Entry	Seasonal Yield[1/] (T/A)
Weevlchek	5.1 a
K9-100	5.0 ab
MsHp6FAn3W3	5.0 ab
Kanza	4.9 ab
KO-2 (Gladiator)	4.9 ab
Saranac	4.8 ab
WL 305	4.8 ab
MsHp6FAn2W2	4.7 ab
WL 309	4.6 ab
N6-614	4.6 ab
ARC	4.6 ab
Vernal	4.5 ab
Buffalo	4.4 bc
Team	3.9 cd
ARS 2	3.8 cd
MSB-CW5	3.8 cd
MSB-CW5An3	3.7 d
Cherokee	3.7 d
KO-8	3.7 d
Williamsburg	3.6 d

1/ Any two means which are not followed by the same letter are significantly different at the 5% level. Duncan's Multiple Range Test.

Table 2. 1975 dry matter yields from two harvests -- 1970 alfalfa strain and variety test at Wye Institute, Maryland

Alfalfa Entry	Seasonal Yield[1/] (T/A)
Team	1.42 a
MsHp8	1.32 ab
MsHp6F-An2W2	1.32 ab
MSA-CW3	1.30 ab
Williamsburg	1.25 abc
MsHp6FOV	1.23 abc
Weevlchek	1.19 abc
Saranac	1.17 abc
Cherokee	1.16 abc
MsHpB3	1.14 abc
Florida-66	1.09 abc
Moapa-69	0.74 bc
DuPuits	0.74 bc
Bonanza	0.67 c

1/ Any two means which are not followed by the same letter are significantly different at the 5% level. Duncan's Multiple Range Test.

Soil-Landscape Relationships of the Tidal Marshes of Maryland

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Purpose and Objectives

There are over 200,000 acres of tidal marsh soils in Maryland. This large area of economically and ecologically valuable soils is poorly understood. Research in other tidal marshes has documented their importance, but certain basic questions remain to be answered. It would be helpful in the management of these areas to know the soil-landscape relationships which may exist. These relationships would facilitate our understanding of the local genesis of tidal marshes, aid in mapping of the associated soils, and give a more sound basis on which to make land use decisions concerning these soils. The objectives of this study were to investigate and model the possible soil-landscape relationships of the tidal marshes of Maryland, and to describe the associated soils and vegetation.

Procedures

A reconnaissance soil survey of the tidal marshes of Maryland was conducted. Soils were observed with the aid of a specially modified bucket auger, McCauley peat sampler and tiling spade for a total of 116 profiles at 42 sites (Fig. 1). Samples retrieved were analyzed for significant parameters by standard techniques modified to suit marsh soils. Vegetation type was recorded at each site. After the preliminary sampling, transects were made across several marshes. Basic soil-landscape relationships and marsh types were then more intensively sampled along transects to test and further develop soil-landscape models.

Results

The tidal marshes of Maryland occur around the perimeter of Chesapeake, Chincoteague, Sinepuxent and Assawoman Bays. They are also found up to the limit of tidal influence in the rivers and streams which drain into the bays. There are approximately 215,000 acres of tidal marsh soils mapped in the State. Three basic soil-landscape relationships were found for the marshes. These coincided with three physiographic units described for the marshes: Coastal, Estuarine and Submerged Upland.

An idealized cross section of a Coastal Type marsh is given in Figure 2. These marshes are found along the perimeter of the bays behind the Atlantic coast barrier islands. These soils have developed from the accumulation of tidal sediments and overwash sand from the beach and dunes in the lagoon behind the barrier island. The predominant vegetation on these marshes is Spartina alterniflora (salt marsh cord grass) in the lower areas with S. patens (salt meadow cord grass) in the higher portions. Salicornia europeae (glasswort) was found growing in small shallow depressions in the back of the marsh. The drainage pattern is well developed and consists of small meandering tidal streams with "pannes" or small shallow ponds scattered over the central portions of the marshes.

The soils of the coastal marshes consist of silty and clayey tidal sediments and sandy overwash sediments. The mineral sediments were overlain in places with up to a meter of peat. The salt content ranged from 69 to 189 ppt NaCl equivalent; total sulfur content ranged from 0.7 to 2.2%; and organic carbon content ranged from 9 to 26%. Chincoteague silt loam, Assateague loamy sand, and Pikes peat soil series are proposed for this marsh type. The mineral soils were classified as Typic Sulfaquents, and the organic soils were classified as Typic Sulfihemists.

Figure 3 portrays an idealized cross section of an Estuarine Type marsh. These marshes have formed from the accumulation of alluvial and tidal sediments and peat in two landscapes or geomorphic positions; these are filled stream valleys and estuarine meanders. This type can be identified by geomorphic location, vegetation, and soil profile characteristics. Drainage systems in the marshes were not as well defined as the coastal type, and pannes were absent. The vegetation varies with the salinity of these marshes. In the low salinity areas, Typha spp (cattail), Spartina cynosuroides (big cord grass) and Pontederia cordata (pickerel weed) are the most common species. Scirpus Olney (three square), Spartina patens, and S. alterniflora are dominant where the salinity is higher. The salinity ranges from 0.5 to 62 ppt NaCl equivalent; total sulfur ranges from 0.1 to 5.1% and organic carbon content ranged from 1 to 44% in the soils. Silt loam to silty clay loam textures were most common in the mineral soils.

Plum silt loam, Fenno silt loam, Tuckahoe peat and Transquaking peat soil series are proposed for the estuarine type marshes. The soils were classified as Typic Hydraquents, Typic Sulfaquents and Typic Sulfihemists, respectively.

The Submerged Upland Type marsh is depicted in an idealized cross section in Figure 4. These marshes formed from inundated former uplands. The Coastal Plain of Maryland has been sinking relative to sea level at a rate of about 0.25 cm per year for the last century. The soils show evidence of translocation of clays and other soil forming processes normally associated with above-water environments. These soils are essentially similar to the soils on adjacent uplands, but are more or less charged with salts from sea water and have a thin histic epipedon. The drainage system is very poorly developed or entirely lacking over most of the vast areas which these marshes encompass.

The vegetation of the submerged upland type marshes is characterized by extensive, almost single species stands of Juncus Roemerianus (needle rush) and Scirpus Olneyi in the brackish areas, and Spartina patens in the more saline areas.

The salinity of the soils ranges from 24 to 107 ppt NaCl equivalent and from 2 to 98 ppt NaCl equivalent for the histic epipedons and mineral horizons, respectively. The organic carbon content ranges from 21 to 38% and from 0.1 to 7.3% for the histic epipedons and mineral horizons, respectively. The total sulfur content ranges from 0.3 to 4.4% and from 0.02 to 0.46% for the histic epipedon and mineral horizons, respectively. The histic epipedon ranged in thickness from 15 to 41 cm. Most of the mineral horizons were silt loam to silty clay loam in texture overlying sand.

Sunken silt loam and Honga peat series were proposed to accommodate most of the submerged upland type marsh soils. The soils were classified as Histic and Typic Halaqualfs and Terric Sulfihemists, respectively.

Summary

Soil-landscape relationships were studied for the tidal marshes of Maryland. Three basic types of marshes with associated landscapes, vegetation and soil characteristics were described. Genesis models were proposed for each type.

The Coastal Type marshes cover 18,300 acres along the Atlantic coast. These marshes have formed as a result of tidal and storm sediments deposited in the bays behind the barrier islands. Spartina patens and S. alterniflora stabilize the sediments and protect them from erosion. The roots of these plants form a histic epipedon in places. Salt content of the soils is very high, greatly restricting the variety of plants which may grow there.

Estuarine Type marshes are similar to Coastal Types in that they have formed as a result of the recent accumulation of sediments. These sediments have been deposited in under-fit stream channels, valley heads and estuarine meanders. The soils consist of deep or shallow peat, muck, or mineral soil. These marshes show the most variation in soil and vegetation. They exist in association with water which is nearly fresh to highly saline. The vegetation varies with the salinity. The species diversity increases with a decreasing salt content. The vegetation does not form a good "turf" as on the Coastal Type marshes. These marshes cover an estimated 80,800 acres in Maryland.

The submerged upland type marshes are the most extensive in Maryland, accounting for 115,300 acres. These marshes have formed as rising sea level inundates low lying uplands, mostly in Dorchester and Somerset counties. A shallow histic epipedon covers mineral soils which trace their genesis to above water environments. The vegetation of these marshes shows strikingly little diversity as few species can tolerate both the waterlogged and high salt conditions.

Acknowledgement

The authors wish to thank Martin C. Rabenhorst for the art work contained within.

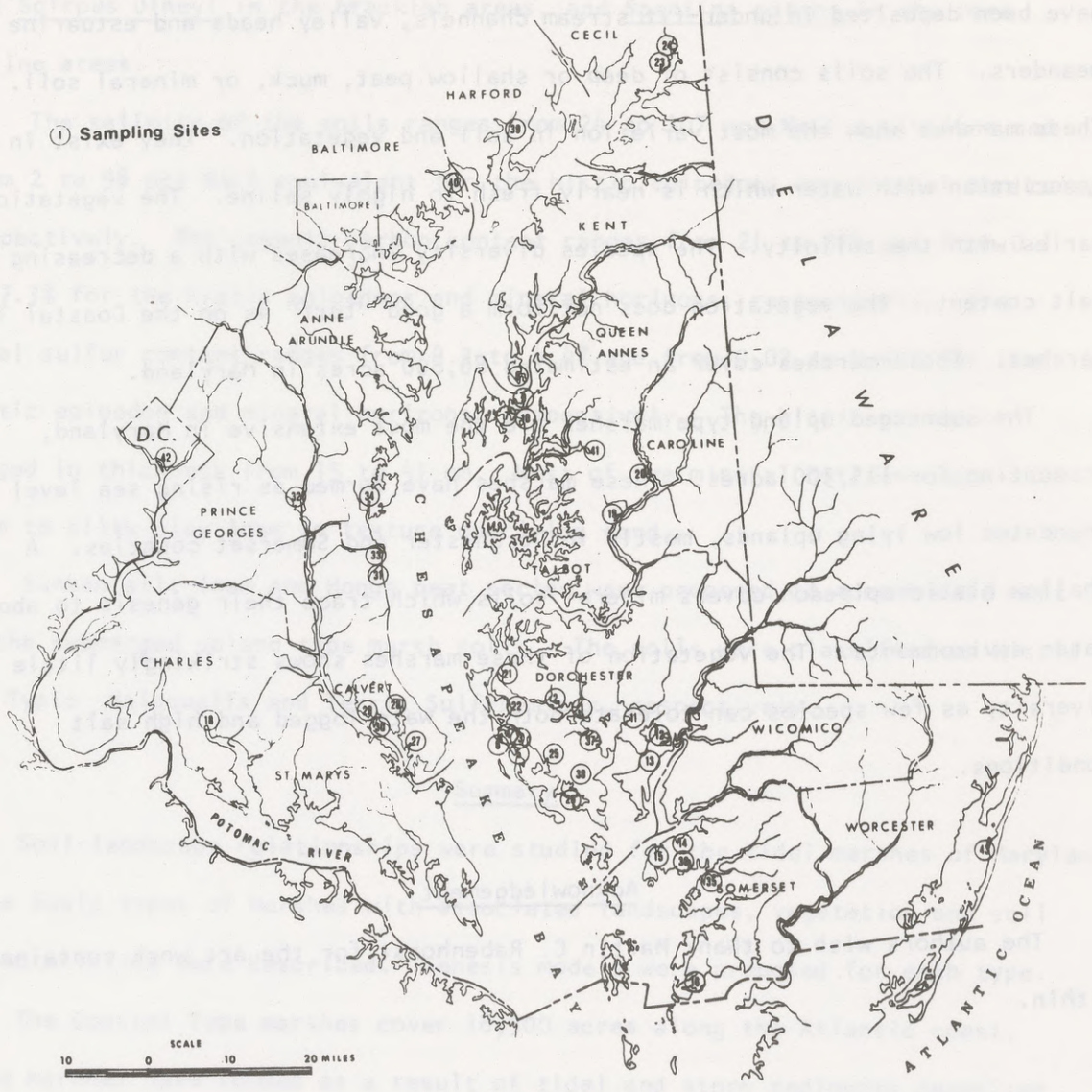
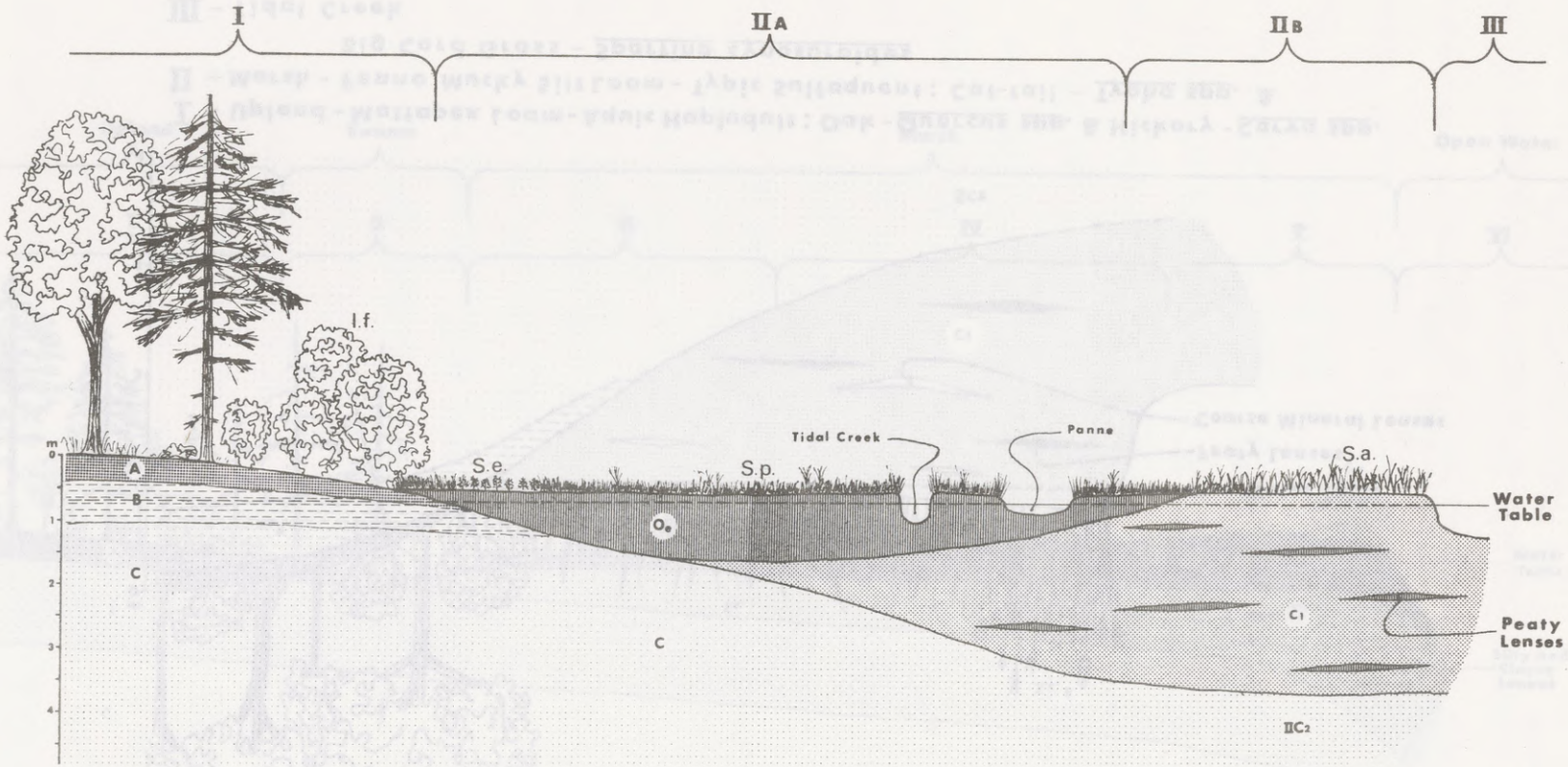


Figure 1. Distribution of Tidal Marsh Sampling Sites



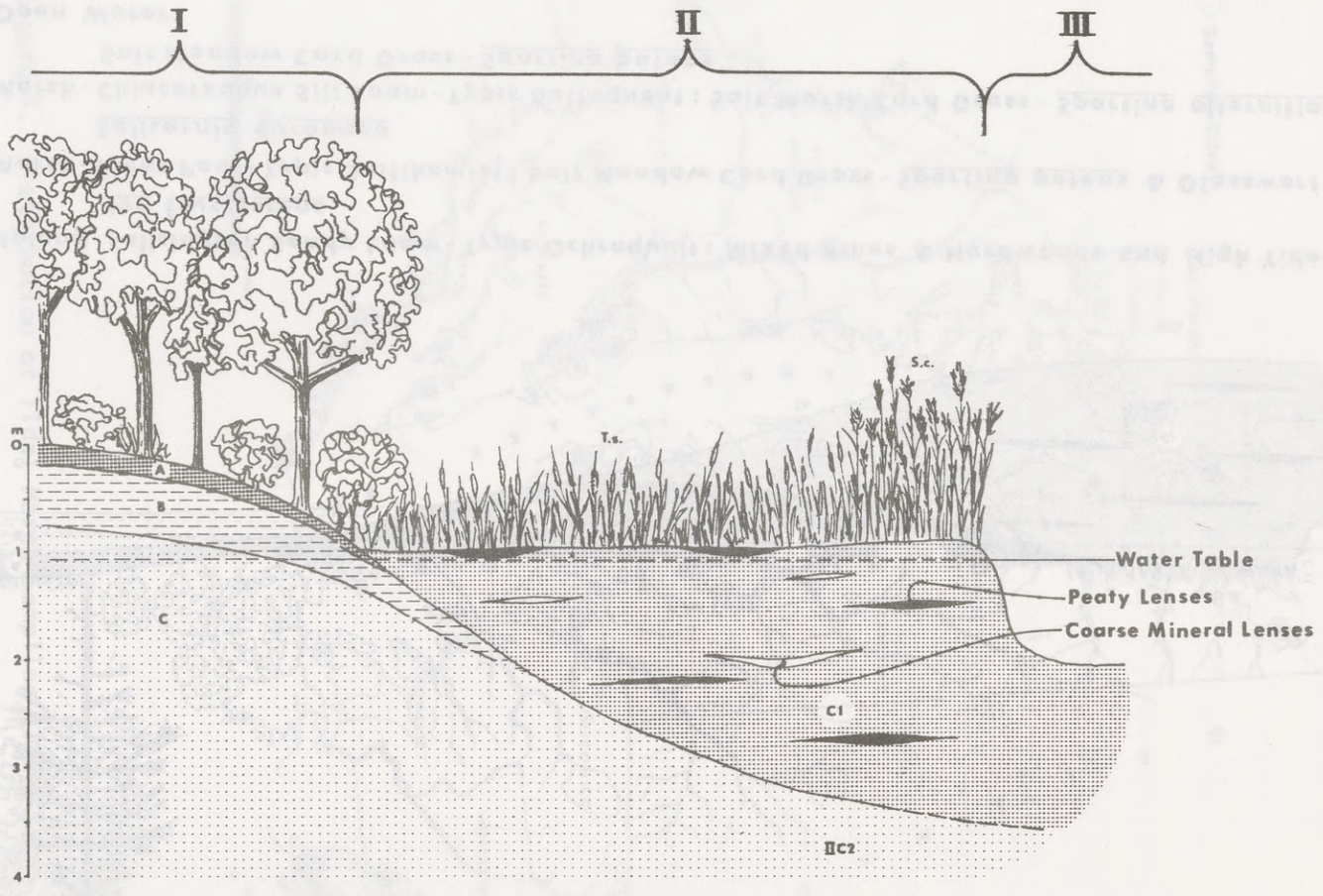
I-Upland - Fallsington Sandy Loam - Typic Ochraquult : Mixed Pines & Hardwoods and High Tide Bush Iva frustescens

IIA-Marsh - Pikes Peat - Typic Sulfihemist : Salt Meadow Cord Grass - Spartina patens & Glasswort Salicornia europaea

IIB-Marsh - Chincoteaque Silt Loam - Typic Sulfaquent : Salt Marsh Cord Grass - Spartina alterniflora & Salt Meadow Cord Grass - Spartina patens

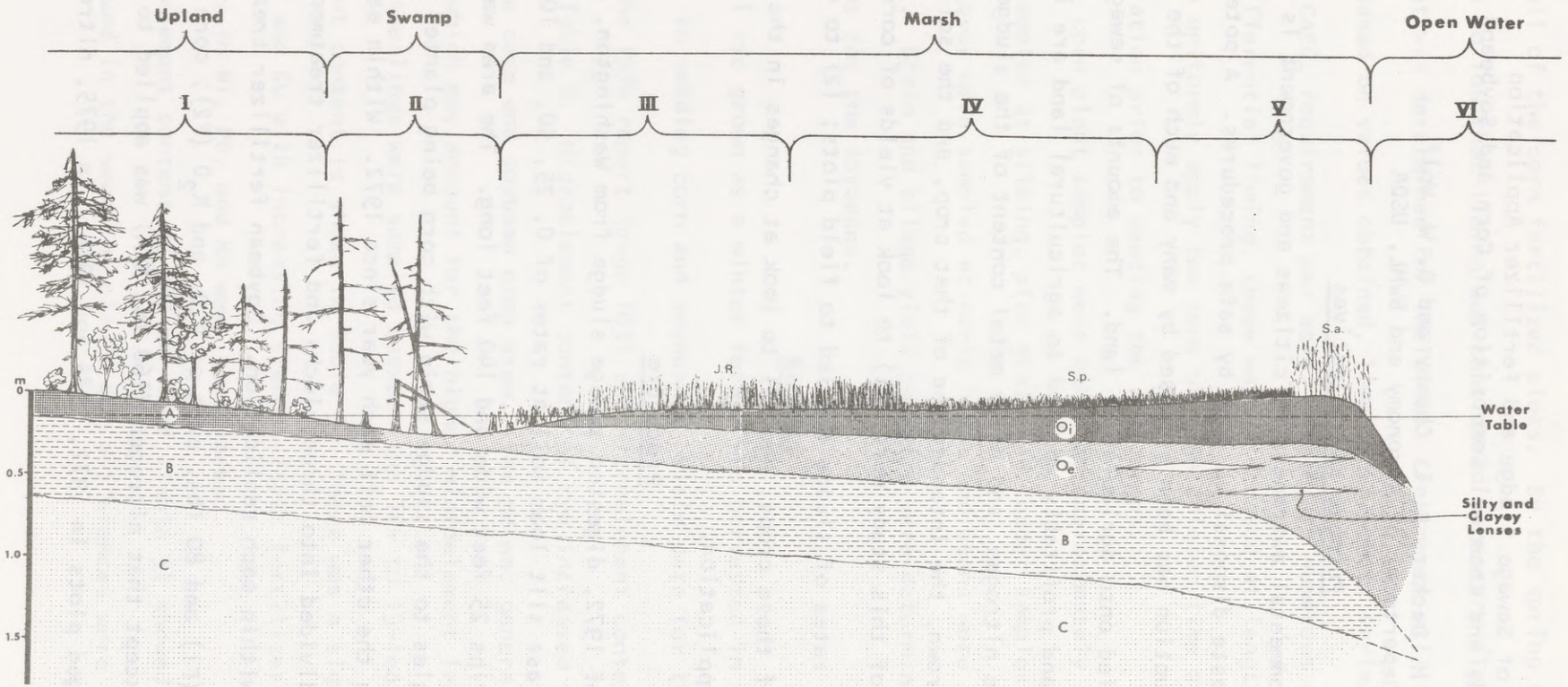
III-Open Water

Figure 2. Idealized Cross Section of a Coastal Type Marsh



I – Upland - Mattapex Loam - Aquic Hapludult : Oak - Quercus spp. & Hickory - Carya spp.
II – Marsh - Fenno Mucky Silt Loam - Typic Sulfaquent : Cat-tail – Typha spp. &
Big Cord Grass - Spartina cynosuroides
III – Tidal Creek

Figure 3. Idealized Cross Section of an Estuarine Type Marsh



I- Elkton or Othello Silt Loam – Typic Ochraquult : Pine Forest – Pinus spp.

II- Swamp – Transitional Unclassified Soil : Pines Dying Out

III- Sunken Silt Loam – Histic Halaqualf : Needle Rush – Juncus Roemerianus

IV- Honga Peat – Terric Sulfihemist : Salt Meadow Cord Grass – Spartina patens & Needle Rush – Juncus Roemerianus

V- Transquaking Peat – Typic Sulfihemist : Salt Marsh Cord Grass – Spartina alterniflora & Salt Meadow Cord Grass – Spartina patens

VI- Open Water

Figure 4. Idealized Cross Section of a Submerged Upland Type Marsh

Effects of Sewage Sludge and Fertilizer Application on the Yields and Chemical Composition of Corn and Soybeans

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Purpose and Objectives

Increased environmental awareness by citizens and government is demanding that municipal waste disposal be done by safe procedures. A potential benefit to crop production has been proposed by many and much of the sewage sludges may be recycled onto agricultural land. The amounts of sewage sludge which can be safely and profitably applied to agricultural land are limited by such things as the nitrogen and heavy metal content of the sludge, the type of crop to be grown, the intended use of that crop, and the soil itself.

The objectives of this study were: (1) to look at yields of corn and soybeans as affected by rates of sludge applied to field plots; (2) to determine heavy metal uptake of these crops; and (3) to look at changes in the soil as a result of sludge application.

Procedure

In the spring of 1972, digested sewage sludge from Washington, D. C. was applied to a Sassafrass silt loam soil at rates of 0, 25, 50, and 100 dry tons per acre in strips 25 feet wide and 140 feet long. The area was divided in half at right angles to the sludge strip with corn being planted in one half and soybeans in the other half each year since 1972. Within each crop half, the area was divided into three blocks and fertilizer treatments were assigned at random within each replication. Soybean fertilizer treatments were no fertilizer (F1) and 80 lbs. each of P_2O_5 and K_2O (F2); corn fertilization was the same except that nitrogen (160 lbs N/A) was applied to the fertilized non-sludged plots in 1972, 1973 and 1974. In 1975, nitrogen was

added to all of the corn fertilized plots. By the spring of 1975, soil pH had fallen so low that liming was considered necessary (Table 1). The lime requirement was determined for individual treatments utilizing the buffer method. Based on values obtained, lime requirements varied from 2630 to 7050 lbs. $CaCO_3$ requirement per acre. There are numerous arguments for and against differential liming; these were discussed at length before it was decided to uniformly apply two tons of high calcium lime during final seedbed preparation prior to seeding the 1975 crops.

Whole corn plant samples were taken at approximately the 12-leaf stage, ear leaf samples at silking, plus grain and fodder samples at grain harvest. Soybean leaves were sampled at early bloom and beans were saved for analyses at harvest. Grain and silage yield per acre were determined for corn and bean yields for the soybeans.

Results

Cereal rye grown as a winter forage was harvested in the spring of 1974 just prior to seeding corn and soybeans. Yield data for these plots were given in the 1974 report (page 103) and microelement content of rye is presented in Table 2. Microelement content of rye increased with sludge rate in both the corn and soybean crop area. The pH was generally lower on the corn area which may account for the higher microelement level.

Corn seedlings were sampled between the 10- to 15-leaf stage and the microelement content is shown in Table 3. There was a significant increase in Zn, Cd, and Cu with increasing sludge rates; fertilizer had little effect. Differences in Ni, Pb, and Mn were less marked.

Microelement content of the ear leaf (Table 3) showed a similar pattern to that found in the seedling plants but differences were less marked and

the actual amounts were less. The actual microelement of the silage samples at crop maturity tended to be intermediate between the values at the seedling stage and for the ear leaf (Table 4). However, the Ni and Pb contents were higher than at the seedling or ear leaf stages. The microelement content of Zn, Cd, and Ni in the corn grain increased significantly with sludge rates. The Ni appeared to increase as the plants matured and to concentrate in the grain while there was much less Zn and Cd found in the grain than in the silage samples.

The microelement content of soybean leaves at flowering was generally less than values found in the corn ear leaf but increases with sludge rates were again rather marked (Table 4). The amount of Ni in the soybean leaf, on the other hand, was substantially higher than in the corn ear leaf. The Cu and Ni content of the beans was much higher than for corn grain.

The increase of Cd in corn grain was as great (0.09 to 0.68 ppm) as occurred in Illinois with Chicago sludge which was at least 10 times higher in Cd. However, the increase in soybean seeds was only 0.07 to 0.24 ppm. These results support findings of other Beltsville studies that high Zn tends to inhibit Cd uptake by soybeans but has little effect on Cd uptake by corn. The Mn and Fe levels in plant tissue were generally decreased by sludge application but did not approach deficiency levels.

The microelement content of soybean leaves and beans (Table 5) was higher than that found in comparable corn samples except for Cd and Mn. The effect of sludge application was similar for both crops even though the actual amounts were greater for soybeans.

The yields of corn and soybeans for 1975 are presented in Table 6. There was a significant increase in both silage and grain yields with the application

of sludge. Silage yields were consistently increased by fertilizer application but the increases were significant only on the non-sludge plots; the effect of fertilizer was more marked for grain yields. There was no difference in soybean yields from either sludge or fertilizer application. Soybean yields were considerably lower than those obtained in 1974 but corn grain yields were comparable for specific treatments.

Summary

1. After four years of cropping corn yields were still increased from the initial sludge application in 1972.
2. The application of N, P, and K fertilizer increased grain yields on both sludged and non-sludged plots. This is in contrast to previous years where no fertilizer response was obtained.
3. There was no difference in soybean yields due either to sludge or fertilizer; this is in contrast to the last two years when sludge increased bean yields.
4. Sludge application increased the amount of Zn, Cd, Cu and Ni in both corn and soybean while Pb and Mn were generally decreased.
5. Fertilizer had little effect on microelement uptake.

Table 1. Elemental analysis and pH of sludge plot soils at Plant Research Farm, May, 1975.

Crop	Sludge Tons/A	Fertilizer[1/]	pH	Mg	P_2O_5	K_2O	Cu	Zn	Mn
				- - - - - - - - Available Lbs. per Acre - - - - - - - - - -					
Corn	0	F1	5.6	114	168	159	1.2	2.2	66
		F2	5.3	67	190	175	1.4	3.3	82
	25	F1	5.4	88	337	107	22	64	89
		F2	5.5	95	390	173	20	58	96
	50	F1	5.4	102	750+	129	59	187	132
		F2	5.5	93	648	153	45	143	123
	100	F1	5.4	109	750+	130	89	322	123
		F2	5.5	115	750+	166	84	304	127
Soybeans	0	F1	6.0	171	175	159	1.5	3.9	71
		F2	5.9	153	212	193	2.3	5.7	74
	25	F1	5.6	105	418	121	24	71	85
		F2	5.5	116	555	138	32	94	89
	50	F1	5.6	125	750+	131	54	168	104
		F2	5.6	129	750+	138	54	170	105
	100	F1	5.5	134	750+	145	84	274	99
		F2	5.5	141	750+	155	76	252	97

1/ F1 = No fertilizer applied

F2 = (zero sludge - corn) 160-80-80 lbs N-P_2O_5 - K_2O

= (25,50,100 sludge - corn) 0-80-80 lbs N-P_2O_5- K_2O

= (all sludge - soybeans) 0-80-80 lbs N-P_2O_5 - K_2O

Table 2. Soil pH and microelement content of cereal rye harvested in the spring of 1974

Treatment		Parts per Million (Dry Weight)					
Sludge[1/] Dry Tons/A	Fertilizer[2/]	Zn	Cd	Cu	Ni	Pb	Mn
				Corn Crop Area			
0	F1	20 d[3/]	0.14 c	5.0 d	1.77 ab	3.3 ab	58 b
	F2	27 d	0.17 c	5.9 d	0.92 b	2.8 b	78 a
25	F1	116 c	0.55 b	9.0 c	1.25 ab	3.5 ab	43 c
	F2	113 c	0.72 ab	9.5 bc	1.42 ab	4.5 a	52 bc
50	F1	173 ab	0.77 ab	11.7 ab	1.83 ab	2.5 b	42 c
	F2	160 b	0.81 a	11.1 abc	1.86 ab	2.2 b	46 bc
100	F1	198 ab	0.95 a	12.1 a	2.13 a	3.0 ab	43 c
	F2	192 ab	0.92 a	12.0 a	2.13 a	3.5 ab	42 c
				Soybean Crop Area			
0	F1	21 c	0.11 d	5.3 e	0.98 f	2.7 ab	45 a
	F2	30 c	0.23 c	6.0 e	0.79 f	2.5 b	47 a
25	F1	103 b	0.62 b	9.0 d	1.27 de	3.9 ab	40 abc
	F2	114 b	0.69 b	9.4 cd	1.27 de	4.1 a	42 ab
50	F1	164 a	0.83 a	11.2 ab	2.21 a	3.5 ab	35 c
	F2	123 b	0.65 b	10.5 bc	1.90 ab	2.8 ab	33 c
100	F1	168 a	0.85 a	11.6 ab	1.50 cd	2.4 b	36 bc
	F2	171 a	0.88 a	12.3 a	1.71 bc	3.4 ab	34 c

1/ Sludge applied in 1972 only.

2/ F1 = No commercial fertilizer applied
F2 (Corn) = 80 lbs. each of P_2O_5 and K_2O plus 160 lbs. N on zero sludge
F2 (Soybean) = 80 lbs. each of P_2O_5 and K_2O

3/ Values with the same letters are from the same statistical population (P = .05)

Table 3. Microelement content of corn seedlings (10-15 leaf stage) and the ear leaf at tasseling time for the 1974 crop

Treatment		Parts per Million (Dry Weight)					
Sludge[1/] Dry Tons/A	Fertilizer[2/]	Zn	Cd	Cu	Ni	Pb	Mn
				Corn Seedling			
0	F1	38 d[3/]	0.78 e	7.7 d	0.69 bc	2.5 a	45 b
	F2	51 d	1.60 d	8.8 c	0.65 c	2.0 a	109 a
25	F1	209 c	3.60 c	10.4 ab	0.54 cd	1.9 a	32 b
	F2	216 c	3.92 bc	9.8 b	0.42 d	2.5 a	36 b
50	F1	320 ab	4.66 ab	10.5 ab	0.65 c	1.6 a	32 b
	F2	269 bc	4.79 a	10.7 ab	0.65 c	1.8 a	33 b
100	F1	369 a	4.68 ab	11.0 a	0.92 a	2.0 a	35 b
	F2	355 a	4.63 ab	10.6 ab	0.81 ab	1.8 a	36 b
				Corn Ear Leaf Sample			
0	F1	20 f	0.35 e	4.4 c	0.48 abc	5.7 b	26 d
	F2	36 ef	0.68 e	8.1 ab	0.40 bc	6.8 a	67 ab
25	F1	79 d	1.93 d	8.0 ab	0.35 c	6.4 ab	41 cd
	F2	70 de	1.82 d	7.9 ab	0.40 bc	6.2 ab	43 c
50	F1	165 c	3.19 bc	8.1 ab	0.42 bc	4.6 c	63 ab
	F2	135 c	2.73 c	7.5 ab	0.65 a	4.6 c	62 b
100	F1	247 a	3.83 a	8.6 a	0.56 ab	4.1 c	76 ab
	F2	210 b	3.62 ab	8.5 ab	0.34 c	4.0 c	79 a

1/ Sludge applied in 1972 only

2/ F1 = No commercial fertilizer; F2 = 80 lbs. P_2O_5 and K_2O on all plots plus 160 lbs. N on zero sludge treatment.

3/ Values with the same letter are from the same statistical population (P = .05)

Table 4. Microelement content of silage and grain samples from 1974 corn crop

Treatment[1] Sludge Dry Tons/A	Fertilizer[2]	Zn	Cd	Cu	Ni	Pb	Mn
		Parts per Million (Dry Weight)					
		Corn Silage					
0	F1	24 c[3]	0.61 d	3.0 b	0.77 bc	8.1 a	70 b
	F2	35 c	0.86 d	5.3 a	0.77 bc	8.6 a	100 a
25	F1	131 b	3.16 bc	4.9 a	0.85 bc	5.7 a	37 c
	F2	120 b	3.00 c	5.6 a	0.71 c	7.5 a	45 c
50	F1	218 a	4.59 ab	5.2 a	1.37 a	5.3 a	38 c
	F2	179 ab	4.08 abc	5.7 a	1.04 abc	8.6 a	43 c
100	F1	289 a	3.95 abc	5.5 a	1.21 ab	7.9 a	50 bc
	F2	268 a	5.33 a	5.6 a	1.17 abc	5.0 a	53 bc
		Corn Grain					
0	F1	23 d	0.07 d	2.2 d	0.58 cd	0.7 ab	8.6 b
	F2	22 d	0.12 d	2.6 bc	0.42 d	0.5 b	12.3 b
25	F1	39 c	0.39 c	2.8 ab	0.79 bc	1.1 a	6.2 b
	F2	34 c	0.41 c	2.7 abc	0.72 bc	0.8 ab	6.4 b
50	F1	50 b	0.58 b	2.8 ab	0.97 ab	1.0 ab	5.6 b
	F2	49 b	0.59 b	3.0 a	1.03 a	0.6 ab	6.4 b
100	F1	60 a	0.68 a	2.7 abc	1.16 a	1.2 a	6.4 b
	F2	60 a	0.68 a	2.5 cd	1.17 a	1.1 a	5.0 b

1/ Sludge applied in 1972 only

2/ F1 = No commercial fertilizer; F2 = 80 lbs. P_2O_5 and K_2O on all plots plus 160 lbs. N on zero sludge treatment.

3/ Values with the same letter are from the same statistical population (P = .05)

Table 5. Microelement content of diagnostic soybean leaves and the beans at harvest from the 1974 crop

Treatments		Parts per Million (Dry Weight)					
Sludge[1] Dry Tons/A	Fertilizer[2]	Zn	Cd	Cu	Ni	Pb	Mn
				Diagnostic Soybean Leaves			
0	F1	22 c[3]	0.13 c	6.4 d	1.62 b	3.5 ab	52 bc
	F2	32 c	0.29 b	8.2 c	2.13 b	3.3 ab	57 ab
25	F1	95 b	0.35 ab	10.1 b	3.29 a	3.4 ab	47 bc
	F2	98 b	0.31 b	10.0 b	3.08 a	3.1 b	46 bc
50	F1	114 b	0.42 ab	11.0 ab	3.42 a	3.8 a	47 bc
	F2	114 b	0.37 ab	10.9 ab	3.67 a	3.3 ab	43 c
100	F1	151 a	0.51 a	11.6 a	3.52 a	3.4 ab	54 bc
	F2	142 a	0.43 ab	11.3 a	3.92 a	3.0 b	58 a
				Soybean Seed			
0	F1	44 d	0.05 e	11.3 bc	2.7 d	1.56 b	29 a
	F2	49 d	0.09 de	10.7 c	2.4 d	0.88 c	30 a
25	F1	80 c	0.12 cde	13.1 a	4.5 c	1.30 bc	23 b
	F2	83 bc	0.15 bcd	12.0 ab	4.9 bc	2.15 a	25 b
50	F1	85 abc	0.15 bcd	12.3 ab	5.6 abc	1.21 bc	22 b
	F2	86 abc	0.19 abc	12.3 ab	5.6 abc	1.32 bc	23 b
100	F1	89 ab	0.23 ab	11.8 bc	6.4 a	0.90 c	24 b
	F2	93 a	0.26 a	11.6 bc	6.0 ab	1.02 c	23 b

1/ Sludge applied in 1972 only

2/ F1 = No commercial fertilizer applied; F2 = 80 lbs. P_2O_5 and K_2O applied per acre

3/ Values with the same letter are from the same statistical population (P = .05)

Table 6. Corn and soybean yields as affected by sewage sludge and fertilizer applications. 1975

Treatment		Yields Per Acre		
Sludge[1] T/A	Fertilizer[2] Lbs/A	Silage Tons	Grain Bushels	Soybeans Bushels
0	F1	6.28 e[3]	25.9 e	25.0 a
	F2	11.25 d	79.9 d	24.8 a
25	F1	14.27 c	86.8 d	23.2 a
	F2	16.05 ab	103.0 c	21.6 a
50	F1	15.77 cd	106.8 b	27.0 a
	F2	16.51 ab	120.5 a	25.7 a
100	F1	16.05 ab	110.7 b	23.4 a
	F2	17.48 a	124.2 a	22.0 a

[1] Sludge applied in 1972 only

[2] F1 = No fertilizer applied
F2 = Corn: 160-80-80 lbs/A
Soybeans: 0-80-80 lbs/A

[3] Values in each column followed by the same letter are from the same statistical population (P = .05)

Minimum Tillage Establishment of Forage Species

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Purpose and Objectives

Thousands of pasture acres in Maryland are located on land too steep for safe conventional tillage operations necessary for complete pasture renovation. Sod seeding (minimum tillage) renovation offers an excellent alternative for improving forage production and quality without the threat of large-scale erosion problems.

The feasibility of successfully utilizing the sod seeding technique is well documented by earlier research at Maryland, but the effectiveness of different tillage and seeding units and herbicides has not been adequately studied.

Five different soil tillage and seeding units were evaluated using five forage species and two herbicides. In 1974 the study dealt with the degree of sod suppression, early stand establishment, and forage production as measured by a single fall harvest. In 1975, the objective was to evaluate residual effects of establishment treatments on forage yields and forage quality as measured by weed infestation.

Procedure

The three experiments (described in detail in Crops & Soils Research Report, Vol. 8, page 94) were located on a Chillum silt loam with a pH of 6.5 and medium levels of P and K. The area was uniformly fertilized with 400 pounds of an 0-20-20 fertilizer in early spring of 1975.

Experiment I The John Deere Grassland Drill using paraquat banded over the row at seeding was compared with (1) the same seeder equipped with a concave disc to remove a 4-inch strip of sod just prior to seeding, (2) wide

flute soil opener - double disc seeder, (3) narrow flute soil opener - double disc seeder, (4) deep ripple soil opener - double disc seeder, and (5) wide flute soil opener with only a presswheel to place the seed. Paraquat (0.5 lbs/acre) and glyphosate (1.5 lbs/acre) were sprayed in a band over the row at seeding to suppress sod growth during establishment. Three harvests were made in 1975 to measure residual effects of establishment treatments; the last two harvests were separated into seeded species, weeds and original grass.

Experiment II Three species (red clover, trefoil, and crownvetch) were sod seeded into the bluegrass-timothy sod where paraquat was applied in 4-inch band over the row at seeding at 0.25, 0.50, and 1.0 pounds per acre. Three residual harvests were made in 1975 as described above.

Experiment III The wide flute soil opener - double disc seeder unit from Experiment I was compared to the Zip seeder. Paraquat (0.5 lb/acre) was compared with glyphosate (1.5 lbs/acre) at both banded and broadcast applications. Five different species were seeded. Two residual harvests were made in 1975 with the second separated into seeded species, weeds, and original grass.

Results

Experiment I Forage yields from three harvests in 1975 are presented in Table 1. In the first harvest, red clover was significantly higher yielding than crownvetch, trefoil or check treatments. There did not appear to be a consistent advantage for any one tillage unit, seed placement unit, or herbicide.

By the second harvest, red clover stands were declining rather markedly so botanical compositions were determined. In the last harvest of 1974, red

clover made up about half of the forage yields and by the second harvest of 1975 that percentage had declined to less than 20% for most treatments. Crownvetch, on the other hand, had increased from around 5% to 15%; the percentage of trefoil had increased also.

There was a continued decrease in the red clover component until it made up only about 10% of total yield by the third harvest. Crownvetch, on the other hand, continued to increase to about 35%. Trefoil increased to about 30% of the total yield. By the third harvest, the weed component was highest in the red clover plots.

Experiment II The harvest yields are given in Table 2. Species responses were similar to those observed in Experiment I. The average yield of the red clover treatments was 1.20 at the first harvest with only 0.76 tons for crownvetch. By the third harvest crownvetch was up to 1.35 and red clover had declined to 0.92. Trefoil was intermediate. There appeared to be some residual effect of paraquat rate at seeding with the 0.5- and 1.0-lb rates being consistently better than the 0.25-lb rate; by the third harvest, however, these differences had largely disappeared.

Experiment III Stands of most of the seeded species had declined and weed infestation was so heavy on many treatments that the experiment was discontinued after the second harvest on July 23. In the first harvest, yields were generally higher on the band than on comparable broadcast plots. By the second harvest, as red clover stands declined, weeds increased markedly. Weeds were almost three times higher in the broadcast plots as in the banded plots; differences in weed infestation between paraquat and glyphosate treatments were small and non-significant. Alfalfa stands were slightly better in the paraquat than in the glyphosate plots.

Summary

1. There appeared to be little difference between paraquat and glyphosate in terms of legume establishment and forage yields.
2. Band application of herbicides was superior to broadcast in terms of both forage yield and weed infestation.
3. Red clover is the easiest legume to establish under sod seeding conditions but stands go out during the second harvest year.
4. Crownvetch and trefoil are slower to establish than red clover but stands tend to increase rather than decline; this is especially true for crown-vetch.
5. The type of soil tillage unit or seed placement units appeared to be less important than sod suppression.

Table 1. Effects of soil tillage and seed placement units, two herbicides, and three legumes on forage yields one year after a spring sod seeding. 1975

Treatment[1]	First Harvest	Second Harvest (7-23)			Third Harvest (10-29)		
	Total Yield (5-27)	Seeded[2] Species	Weeds	Total	Seeded[2] Species	Weeds	Total
Check	.90 e[3]	.05 e	.07 a	.46 a	.26 b-f	.19 a	1.29 a
C-S-CV	.95 de	.16abc	.09 a	.59 a	.51 a	.24 a	1.35 a
C-S-RC	1.66 a	.19 a	.07 a	.62 a	.15 def	.18 a	.94 a
C-S-TR	1.22 bc	.07cde	.08 a	.55 a	.29 b-e	.14 a	1.01 a
ST-S-CV-P	.88 e	.11a-e	.07 a	.47 a	.42 a	.14 a	1.23 a
ST-S-RC-P	1.34 bc	.14a-d	.09 a	.56 a	.15 def	.26 a	1.10 a
ST-S-TR-P	.94 de	.07cde	.07 a	.47 a	.34 a-d	.20 a	1.20 a
W-D-CV-P	.90 e	.14a-d	.09 a	.58 a	.42 ab	.20 a	1.38 a
W-D-RC-P	1.47 ab	.14a-d	.08 a	.56 a	.16 def	.24 a	1.24 a
W-D-TR-P	.98 de	.06 de	.07 a	.46 a	.32 a-d	.17 a	1.23 a
W-D-CV-G	.98 de	.15a-d	.08 a	.57 a	.36 abc	.20 a	1.14 a
W-D-RC-G	1.52 ab	.20 a	.09 a	.65 a	.14 def	.29 a	1.09 a
W-D-TR-G	1.09 cd	.09b-e	.08 a	.52 a	.36 abc	.18 a	1.26 a
W-PW-RC-P	1.51 ab	.18ab	.08 a	.62 a	.10 ef	.28 a	.98 a
N-D-RC-P	1.40 ab	.15a-d	.10 a	.64 a	.18 def	.24 a	1.08 a
DR-D-RC-P	1.47 ab	.15a-d	.07 a	.55 a	.08 f	.30 a	.98 a
C.V. %	15.0	19.6	14.7	18.5	23.6	18.9	19.6

[1] C = Concave disc, ST = Straight disc, W = Wide flute, N = Narrow flute, DR = Deep ripple, PW = Presswheel only, S = Spear seeder, D = Disc seeder, RC = Red clover, CV = Crownvetch, TR = Trefoil, P = Paraquat, G = Glyphosate

[2] Seeded species for all treatments except check where value is total legume present.

[3] Any two means not followed by the same letter are significantly different at 5% level.

Table 2. Effects of three paraquat rates on forage yields one year after a spring sod seeding. 1975

Treatment[1]	First Harvest	Second Harvest (7-23)			Third Harvest (10-29)		
	Total Yield (5-27)	Seeded[2] Species	Weeds	Total	Seeded[2] Species	Weeds	Total
Check	.64 c[3]	.08 e	.09 a	.52 c	.34 cd	.14 a	1.17 bcd
RC-LP	1.06 ab	.24a-d	.08 a	.74 ab	.19 de	.14 a	.97 de
RC-MP	1.29 a	.36 a	.07 a	.86 a	.14 e	.20 a	.97 de
RC-HP	1.26 a	.32 ab	.09 a	.89 a	.18 de	.15 a	.83 e
AV	1.20 A	.31	.08 A	.83 A	.17 C	.16 a	.92 A
CV-LP	.71 c	.18b-e	.08 a	.64 bc	.55 ab	.14 a	1.36 ab
CV-MP	.76	.28abc	.07 a	.75 ab	.67 a	.11 a	1.48 a
CV-HP	.81 bc	.30abc	.07 a	.74 ab	.49 bc	.12 a	1.22 bc
AV	.76 B	.25	.07 A	.71 A	.57 A	.12 a	1.35 A
TR-LP	.75 bc	.12de	.09 a	.64 bc	.41 bc	.12 a	1.36 ab
TR-MP	.78 bc	.16cde	.07 a	.65 bc	.37 c	.11 a	1.16 bcd
TR-HP	.90 bc	.20bcd	.08 a	.76 ab	.38 bc	.14 a	1.13 cd
AV	.81 B	.16	.08 A	.68 B	.39 B	.12 a	1.22 A
LP	.84 X	.18 X	.08 X	.67 X	.38	.13 X	1.23 X
MP	.94 X	.27 X	.07 X	.75 X	.39	.14 X	1.20 X
HP	.99 X	.27 X	.08 X	.80 X	.35	.14 X	1.06 X
C.V. %	11.0	11.4	6.1	7.7	13.7	18.5	11.2

1/ RC = Red clover, CV = Crownvetch, TR = Trefoil, LP = $\frac{1}{4}$ lb. paraquat, MP = $\frac{1}{2}$ lb. paraquat, HP = 1 lb. paraquat (paraquat applied in 4-6 inch band over row at seeding).

2/ Seeded species for all treatments except check where value is total legume present.

3/ Any two means not followed by the same letter are significantly different at the 5% level. Capital letters for main effects.

Table 3. Effects of band and broadcast application of two herbicides and two sod-seeding machines on forage yields one year after a spring sod-seeding. 1975

Treatment[1]	First Harvest Total Yield (5-27)	Second Harvest (7-23) Seeded[2] Species	Weeds	Total
Check	.88 ef[3]	.05 d	.16 c	.68 e
WD-PB-RC	1.47 bc	1.18 a	.45 b	1.63 a
WD-PB-TF	.84 ef	.24 bcd	.54 b	.78 e
WD-GB-RC	1.43 bc	.86 a	.63 ab	1.49 ab
WD-GB-TF	.68 f	.42 be	.37 bc	.80 e
ZP-GB-RC	1.68 ab	1.00 ab	.64 ab	1.64 a
ZP-GB-TF	.69 f	.42 bc	.39 ab	.80 e
ZP-GB-TR	1.35 bcd	.60 b	.60 ab	1.20 cd
ZP-GB-AL	1.15 cd	.50 bc	.64 ab	1.22 c
ZP-PB-RC	1.56 ab	1.08 a	.55 ab	1.62 a
ZP-PB-TF	.92 ef	.33 bcd	.55 ab	.89 de
ZP-PB-CV	1.04 de	.41 bc	.86 a	1.27 b
ZP-PB-AL	1.59 ab	1.15 a	.59 ab	1.78 a
ZP-P-RC	1.83 a	.82 a	.19 c	1.59 ab
ZP-P-TF	1.02 e	.01 d	.16 c	.80 e
ZP-G-RC	1.63 ab	.56 b	.22 c	1.28 b
ZP-G-TF	1.01 e	.16 cd	.15 c	.65 e
C.V. %	9.2	19.3	20.2	8.0

1/ WD = Wide flute with disc seeder, ZP = Zip seeder, PB = Broadcast paraquat, P = Banded paraquat, GB = Broadcast glyphosate, G = Banded glyphosate, RC = Red clover, TF = Tall fescue, TR = Trefoil, AL = Alfalfa, CV = Crown-vetch.

2/ Seeded species for all except check treatment where values are total legumes present.

3/ Any two means which are not followed by the same letter are significantly different at the 5% level.

Pasture Improvement With Sod Seeding

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Purpose and Objectives

Beef consumption in the United States and other developed countries continues to increase. From 1952 to 1972, per capita beef consumption in the United States has gone from 62 to 116 pounds. With increasing world demands on feed grains, more and more of the feed for this increasing beef industry must come from forages. There are, currently, several million acres of land in Maryland and the Northeast which are idle with respect to agriculture production. Much of this idle land can be used to produce high yields of quality forages; because of steep terrain and other limiting factors, the most effective use of much of these idle acres appears to be grazing. These acres can be used to raise dairy replacement females, feed out dairy steers for beef, or increase beef cattle operations *per se*.

Development of efficient pasture systems is the key to economical use of land awaiting the land speculator, or land that is too steep or otherwise unsuited for intensive crop production.

Procedure

An orchardgrass pasture was taken out of production during the mid-1960's and allowed to revert to bluegrass, herbaceous weeds, and woody brush species. During the summer of 1974, the large woody species were removed and the area was cut with a bush hog. During September, 1974, the area was divided into 20 three-quarter acre paddocks. These paddocks were divided into two replications and within each replication three sets of three paddocks each, having comparable soil and vegetative cover, were grouped. Three pasture treatments were assigned at random within each of these uniform paddock groups. These

pasture treatments were (1) weed and brush removed plus 350 pounds of an 0-15-30 fertilizer, (2) weeds and brush removed, fertilization, and sod seeding to alternate rows of a red clover-ladino clover mixture and 'Penngift' crownvetch, and (3) same as treatment two with "Spreader" alfalfa rather than 'Penngift' crownvetch.

The sod seedings were made with a Zip seeder equipped with a band seeding attachment to spray a 4 to 5 inch band of paraquat over each row as the legumes were seeded.

Pastures were scheduled to be grazed starting in mid-April, but problems with the water system, fences, and animal availability delayed start of grazing until the first week in June. The pastures were clipped twice to control forage growth and one set of paddocks in each replication was harvested for hay in mid-June because there were not enough available animals to keep up with forage growth. Grazing continued until October 2, 1975.

The test animals were dairy replacement heifers and dairy steers. There were two tester steers and two tester heifers assigned to each pasture treatment within each replication. Grazers were added as needed to insure uniform utilization of all pastures. The pastures were grazed in a three-paddock rotational system with animals being weighed each time they were moved from one paddock to another. This varied from 8 to 21 days.

After the animals were removed from the pastures, stand counts and botanical compositions were determined for each paddock, including those extras used for grazers not on test paddocks. Six thirty-foot transects per paddock were used to determine plant numbers of alfalfa and crownvetch. Six 1-by 2-ft. quadrates were taken per paddock to determine percent ground cover of red clover, white clover, alfalfa, crownvetch, grass and weeds.

Results

The carrying capacity was significantly increased by sod seeding legumes into the pastures (Table 1). The higher value for crownvetch was due to a better stand of red clover and not to a difference between crownvetch and alfalfa; the seeder performed erratically on the alfalfa paddocks.

Daily animal gains were significantly higher as a result of the sod seeded legumes. Better animal performance and higher pasture carrying capacity resulted in significantly more animal gains per acre with sod seeding (Table 1).

At the end of the grazing season all test animals were independently graded by four individuals. A summary of these evaluations is presented in Table 2. The condition of animals on the sod seeded pastures was consistently better than on the check pastures. Most animals were in good to excellent condition; the higher amount of clover in the crownvetch treatment resulted in the highest average condition.

Botanical composition of the pastures at the end of the grazing season was determined by making ground cover estimates in six 1 by 2 ft. areas in each paddock; a total of 36 determinations were made for each pasture treatment. These data are presented in Table 3. The check pastures were about 25% weeds, 25% open space, and about 50% grass cover; in some of the paddocks the grass was mostly Kentucky bluegrass while others were largely orchardgrass or mixtures of the two species. There tended to be more open space in the predominantly orchardgrass paddocks.

In the crownvetch paddocks, there was consistently less open space and significantly fewer weeds; the weeds were largely replaced with red and white clover.

The pattern for alfalfa was similar to that found for the crownvetch

treatment. The major difference was a much lower percentage of red clover and a higher percent of weeds and open space. The lower percentages of red clover resulted from a malfunction of the seeder which was not detected until after the stands were up and then the machine was checked.

The red clover was seeded in both sod seeded pastures to furnish high clover production during the first grazing season; as the red clover stands thin out during the second grazing season, the white clover, crownvetch, and alfalfa will be the major legume components. Since crownvetch and alfalfa were the major difference between the sod seeded pastures, stand counts were made of these two species at the end of the first grazing season. These data are shown in Table 4. Plant numbers were low for both species. Individual paddocks were quite variable but crownvetch plants were generally more abundant than alfalfa. Crownvetch and alfalfa stands tended to be weakest where the red clover was especially heavy.

Percent ground cover and plant numbers will be determined just prior to starting the 1976 grazing.

Summary

1. Pasture carrying capacity was increased with sod seeding.
2. Pasture quality as measured by animal performance was increased by sod seeding.
3. Animal gains per acre were increased with sod seeding.
4. Crownvetch, alfalfa, and white clover were slower to establish than red clover.
5. Sod seeding reduced the amount of weeds present and the amount of open bareground space.

Table 1. Pasture carrying capacity, daily animal gain and pounds of gain per acre, 1975.

Pasture Treatment	Pasture Carrying Capacity[1/]	Animal Gains Lbs/Day	Pounds Beef Per Acre
Check pastures	2.50 c[2/]	0.74 b	62.2 b
Sod seeded red clover and crown vetch	3.31 a	1.30 a	166.7 a
Sod seeded red clover and alfalfa	2.89 b	1.40 a	139.2 a

1/ Number of 700 pound animals per acre

2/ Values in each column with the same letter are from the same statistical population at P .05.

Table 2. Cattle condition at the end of the grazing season, 1975.

Pasture Treatment	Heifers	Steers	Average
Check pastures	3.06[1/]	2.69	2.88
Sod seeded red clover and crown vetch	3.59	3.59	3.59
Sod seeded red clover and alfalfa	3.33	3.23	3.28

1/ 1 = Poor; 2 = Fair; 3 = Good; 4 = Very Good

(Values are averages of four animals independently rated by four individuals.)

Table 3. Percent ground cover at the end of the first grazing season. Determinations were made one month after animals were removed, 1975.

Paddock Cycle	Crown-vetch %	Alfalfa %	Red Clover %	White Clover %	Grass %	Weeds %	Open Space %
			Check Pastures				
A			0.4[1/]	0.0	42.7	27.5	23.4
B			0.2	0.1	60.2	20.8	18.8
C			0.0	0.0	55.8	14.2	29.2
Av.			0.2	0.1	52.9	20.8	23.8
		Sod Seeded Red Clover, White Clover, and Crownvetch					
A	1.2		17.8	4.6	50.0	5.6	20.8
B	1.1		17.9	4.6	59.8	4.2	17.5
C	3.9		18.2	2.6	50.1	4.8	20.2
Av.	2.1		18.0	3.9	53.3	4.9	19.5
		Sod Seeded Red Clover, White Clover, and Alfalfa					
A		0.2	6.6	2.5	55.2	15.6	19.8
B		1.2	6.0	1.6	57.2	13.4	20.2
C		0.6	9.3	6.0	62.0	7.6	20.0
Av.		0.7	7.3	3.4	58.1	12.2	20.0

[1/] Averages of 12 randomly located areas 1 by 2 feet in size

Table 4. Average number of plants along a line transect 30 feet long at the end of the first grazing season, 1975.

Seeded Species	Paddock Cycle A No.	B No.	C No.	Average No.
Crownvetch	1.2	3.4	10.6	5.1
Alfalfa	1.5	6.9	2.0	3.5

Nitrogen Mineralization in a Beltsville Sandy Loam Amended with Composted Sewage Sludge

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Purpose and Objectives

The need for a method of disposal of solid waste has directed attention to the possible use of composted sludge as a soil amendment. Composted sludge can have a beneficial affect upon the chemical, microbiological and physical properties of the soil. Of particular interest is the change in NO_3-N levels in compost amended soils. Plants grown on soil with high NO_3-N levels can result in toxicity to farm animals and infants. Nitrate leachates can pose a potential pollution hazard if streams or wells are contaminated.

This study was undertaken to determine the amount of nitrogen mineralization occurring in a soil amended with various levels of composted sewage sludge.

Procedure

A Beltsville sandy loam (pH 5.4) was air dried and passed through a 2 mm sieve. Composted sludge from the Beltsville Agricultural Research Center composting site was added to 25g soil samples at rates equivalent to 0, 25, 50, 80, 160, 320 dry tons/acre. The samples were maintained at 60% of water-holding capacity throughout the course of the study and incubated at room temperature in the dark. Samples were taken at 14, 28, 42, and 56 days for NO_3-N, NH_4-N and pH analysis.

Analysis of NH_4-N and NO_3-N was conducted by the semi-micro Kjeldahl method. Measurement of pH was made on a soil sample-distilled water mixture (1:1 by weight).

Results

The NH_4-N levels and pH of the samples remained relatively un-

changed throughout the course of the study. However, levels of NO_3-N increased significantly with increasing application rates of composted sewage and with time (Table 1). The interaction of time of sampling with rate of compost incorporation was not statistically significant which indicated that the NO_3-N rate of formation was similar over time at all levels of compost incorporation.

The mean NO_3-N levels increased steadily with application rate, from 28 ppm at 0 T/A to 240 ppm at 320 T/A when averaged over time of sampling. The NO_3-N levels at the 320 T/A compost rate were significantly higher at the 5% level of probability than all other treatments. Levels of NO_3-N averaged over application rates increased from 84 ppm at 28 days to 109 ppm at 56 days.

As a potential pollutant, NO_3-N is of greatest significance when dissolved in soil solution. It should be noted that the soil solution concentration of NO_3-N in this study will be higher than the concentration of NO_3-N in this study will be higher than the concentration based upon soil weight. For example, at 320 T/A of composted sludge, the soil solution concentration is 850 ppm as opposed to 240 when based upon soil weight.

After eight weeks of soil incubation under optimum conditions for nitrification, it was calculated that addition of composted sludge resulted in the production of approximately 2 lbs. of NO_3-N per dry ton of compost per acre. However, it should be noted that no correction was made for that amount of NO_3-N that would normally be leached from the system.

Summary

The levels of NO_3-N in soils amended with composted sludge increased with application rate and time. The levels of NH_4-N and pH remained relatively constant throughout the eight week experiment.

Under optimum conditions for nitrification and nitrate leaching, NO_3-N pollution from soils amended with high rates of composted sewage sludge is possible.

Acknowledgement

Financial support for this research was provided by the U.S. Department of Interior, National Park Service, Washington, D.C.

Table 1. Means of NO_3-N values occurring in a Beltsville sandy loam amended with five levels of composted sewage sludge.*

Compost Rate (T/A)	Time (Days) 28	56	Mean
	--------ug NO_3-N/g dry soil----------		
0	26.5	31.9	28.0^{e}
25	35.7	57.1	45.3^{de}
50	50.0	69.7	57.4^{cd}
80	67.2	86.0	80.7^{c}
160	110.9	205.8	152.5^{b}
320	215.5	254.5	240.4^{a}
Mean	84.3^{a}	109.3^{b}	

*Means followed by the same letter are not significantly different at the 5% level of probability using the Duncan's Multiple Range Test.

Tee Turf Research

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Purpose and Objectives

This experiment was designed to determine if increased traffic resistance can be obtained from a combination of management techniques and mixtures of grasses. More traffic resistant turf will benefit golf courses, athletic fields, tennis courts and schools.

The objectives were: (1) to evaluate the traffic bearing potential of zoysiagrass, bermudagrass, bluegrass and bentgrass alone and in two-way combinations and (2) to determine management factors that provide the greatest healing potential, quality and traffic resistance.

Procedures

In the early summer of 1973, stolons of 'Meyer' and 'Midwest' Zoysia and 'Tufcote' and 'Tifgreen' bermudagrass were planted at a rate of 4 bushels per 1,000 sq. ft. The plot design was a split-split plot with four replications. Individual plot size was 5' by 5'. Plots were located on a Beltsville silt loam at the Plant Research Farm near College Park.

In September, 1973, the four warm season varieties were overseeded to a blend of five Kentucky bluegrass varieties and to 'Penncross' creeping bentgrass. Thus, warm season and bluegrass combinations were evaluated and compared to warm season and bentgrass combinations as well as pure stands of each species. One-half of each replication received 1/8 inch of topdressing in May of 1974 and 3 applications in May, July and October of 1975.

Warm and cool season nitrogen fertilizer programs were initiated in May, 1974. These programs consisted of a 2 pound N application as ureaformaldehyde in late August. Additionally, the warm season program included 4-1 pound N

applications/1000 sq. ft. as ammonium nitrate between early May and mid-August while the cool season program included 4-1 pound N applications/1000 sq. ft. after the bermuda goes dormant in October and before mid-March. Plots were mowed at 3/4 inches in the summer and 1 inch from September to early May.

Results

The results reported are for the second data year, 1975. Comparisons are made to the first year's results and conclusions are tentative.

The amount of zoysia present in 1975 appeared to be slightly less or equal to that present in 1974. As in 1974, the zoysia appeared to be suppressed when in association with bentgrass more than with bluegrass. Zoysia was not encouraged by warm season fertilization nor discouraged by the cool season fertilization. Zoysia was the only grass species of the four tested which did not appear to respond to the fertilizer treatments.

The amount of bluegrass present in 1975 was similar to 1974. As in 1974 the amount present was high in spring and low in fall. Also there was significantly less bluegrass in bermudagrass plots than in zoysia plots. As in 1974 the bluegrass was adversely affected by warm season fertilization.

The amount of bermudagrass present in 1975 was similar to 1974. The amount present in the spring started off at a level somewhat less than the spring of 1974 but by the end of the summer reached 1974 levels and exceeded them on combination plots with bentgrass. Bermudagrass aggressively dominated all treatments by September, 1975 so that 66% of the total plot area was visually estimated to be occupied by this species.

The amount of bentgrass present in 1975 was similar to that present in the spring of 1974. For both years the greatest amount was present in mid-summer and the lowest amount in early fall. There was a sharp reduction in the amount of bentgrass during August of 1975. This was apparently caused by

a combination of drought, disease and chinchbugs. By September, this reduction resulted in reduced quality scores, increased bare ground and weediness in those plots dominated by bentgrass in spring and early summer. The plots dominated by bentgrass at these times were combination plots with zoysia and the solid bentgrass plots. Bentgrass-bermudagrass plots however lost less bentgrass since they contained less originally (the % loss was the same) and the bermudagrass replaced the bentgrass to result in continued high quality.

In early spring under the warm season fertilizer program zoysia and zoysia combinations had higher verdure and higher quality then bermuda and bermuda combinations because zoysia did not crowd out the cool season grasses in the summer to the extent that bermuda did. However, the zoysia combinations which were favorable in the spring were rated very low at the end of summer and early fall because of the blotchy appearance of the dormant zoysia.

The first significant difference between topdressing treatments occured in September, 1975. The percentage of bentgrass was 100% greater in topdressed plots than in those plots not topdressed. There was no bentgrass visible in September on plots receiving the summer N fertilizer program, thus the effect of topdressing was observed only on winter fertilized plots.

In November the percentage of bentgrass further increased on the topdressed plots receiving winter N (Table 1). This resulted in a decrease in the visual estimate of bermuda present and in increased quality (Table 2).

Summary

Zoysia was unresponsive to fertilizer treatments. The percentage composition of all grasses in 1975 was similar to that found in 1974 with bentgrass dominating in early spring and bermudagrass dominating over all treatments by late summer. High quality scores in summer were mostly obtained by bentgrass-bermudagrass combinations. In the fall, topdressing resulted in

improved recovery of the bentgrass under winter N application and thus higher quality scores for plots receiving winter N and topdressing.

Table 1. Percent 'Penncross' creeping bentgrass as visually estimated in November, 1975, for two topdressing treatments as affected by two nitrogen fertilizer programs. Values are averages for 12 grass combinations.

Topdressing Trt.	Fertilizer Programs	
	Summer Nitrogen	Winter Nitrogen
3 applications	1c[1/]	37a
None	0c	9b

[1/] Values with same letter are from the same statistical population at the 5% level of significance.

Table 2. Turf quality[1/] as visually estimated in November, 1975, for two topdressing treatments as affected by two nitrogen fertilizer programs. Values are averages for 12 grass combinations.

Topdressing Trt.	Fertilizer Program	
	Summer Nitrogen	Winter Nitrogen
3 applications	2.8c[2/]	6.3a
None	2.8c	4.5b

[1/] Turfgrass quality rating made on a 0-9 scale with 9 equaling maximum turf quality and 0 equaling a dead, bare or completely weed covered plots. A rating of 6 or greater is considered acceptable.

[2/] Values with same letter are from the same statistical population at the 5% level of significance.

Effect of Sucker Control Agents, Method of Application and Time of Harvest on Maryland Tobacco

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Purpose and Objectives

Maryland growers have converted to the use of sucker control chemicals in the past few years. There are practical problems in the application of suckering agents brought on by the reliance of many large growers on custom operators. It is necessary for the custom operator to treat the grower's total tobacco acreage in one visit as it would be too costly to make repeat visits to the farm. It is often impossible for the grower to top his entire crop before the applicator visits because of labor restrictions. Thus there are practical advantages for custom operators to apply sucker control agents to untopped tobacco.

Another problem resulting from decreased labor availability is that tobacco is now harvested over longer periods of time after topping which could have a significant effect on quality and yield. Maryland leaf is noted for its thin body and high filling power — quality characteristics that should be preserved.

Systemic sucker control agents are most popular in Maryland but contact type chemicals have some place on small crop acreages. Combinations of systemic and contact sucker control agents have proven profitable in the flue-cured area and should be investigated under Maryland conditions which are considerably different than flue-cured.

Consequently this study was initiated to compare sucker control agents and different methods of application. The objectives were:

1. To compare chemical suckering agents and various methods of application of these suckering agents and their effect on sucker control, yield, price and acre values of Maryland tobacco.
2. To determine the effect of time between treatment and harvest for various sucker control methods on yield, price and acre values and sucker control.

Procedures

This experiment was located on a Monmouth fine sandy loam at the Tobacco Experimental Farm. Md. 10 variety was transplanted at a population of 6,223 plants per acre with 60-120-180 lbs. of fertilizer broadcast per acre. Four replicates were used in a split plot design with the time of harvest as whole plots and sucker control methods as the sub plots.

Transplanting was carried out on June 4, 1975 and topping was completed August 8, 1975 when approximately 70% of the plants showed open flowers.

Treatments were:

1. Control — Topped August 8, 1975 with no sucker control used.
2. Systemic — Topped August 8 and sprayed with MH-30 at 1 pint per 1000 plants.
3. Systemic — MH-30 at 1 pint per 1000 plants sprayed on August 3 and topped August 8.
4. Contact — Topped August 8 and a contact suckering agent applied.
5. Sequential — Contact agent applied August 3, topped on August 8 and sprayed with MH-30.

There were two harvest dates of August 18, 1975 and August 28, 1975, resulting in 75 days and 85 days, respectively, from transplanting to harvesting. At the time of harvest suckers were removed from the plot and weighed and counted to determine the effectiveness of sucker control.

Yield, price per pound and acre values were computed for the cured leaf using the standard grades as established by Tobacco Division of the Consumer and Marketing Service of the U. S. D. A.

Results

Rainfall was near optimum during the transplanting period but there were periods in June and July that were dry. Adequate rains in August resulted in heavy sucker growth.

The 1975 results are summarized in Table 1 where data for the various suckering agents are combined across the two harvest dates. Best sucker control was obtained with maleic hydrazide applied before topping with 98 per cent control and the contact combined with maleic hydrazide giving 99 per cent control.

When the early harvest date only was considered sucker control was satisfactory for all treatments. Maleic hydrazide at time of topping gave 86 per cent control, maleic hydrazide applied before topping resulted in 96 per cent, the contact agent gave 85 per cent and contact plus maleic hydrazide also gave 99 per cent control of suckers. At the late harvest date sucker control was 85 per cent for maleic hydrazide used at time of topping, 99 per cent where maleic hydrazide was applied before topping, 68 per cent for the contact suckering agent and 99 per cent for the sequential treatment of a contact agent followed by maleic hydrazide.

Yield per acre and acre value of tobacco was higher when maleic hydrazide was used before topping. Yields and acre values were lower for the treatments of maleic hydrazide at topping and the contact suckering agent.

There was no appreciable effect on price per hundredweight of the cured leaf by any of the suckering agents. The late harvest date resulted in a lower price per hundredweight.

Summary

The objective of this research was to compare the following sucker control agents and methods of application: maleic hydrazide at time of topping, maleic hydrazide applied approximately one week before topping, a contact chemical at time of topping, a contact approximately one week before topping plus maleic hydrazide at time of topping and a control treatment with no suckering agent used.

Measurement of both sucker numbers and weights of suckers indicated better sucker control for all treatments when compared to the untreated control.

Best sucker control was obtained with maleic hydrazide applied before topping with 98 per cent control and the contact combined with maleic hydrazide giving 99 per cent control.

Tobacco yields and acre values were higher where maleic hydrazide was applied before topping, intermediate when the sequential of a contact followed by maleic hydrazide was used and lower where maleic hydrazide at topping or a contact was used. The late harvest date resulted in a reduced price per hundredweight.

Table 1. Effects of sucker control treatments and time of harvest on sucker weight, yield, price and acre values of Maryland tobacco. 1975.

Treatment	Yield Lbs/A	Price $/Cwt	Acre Value $/A	Suckers % Control	Suckers Weight per plot Lbs	Suckers Number per plot
Between Chemical Treatments						
1. Control	1312	92.04	1207	0	14.45	204
2. Maleic hydrazide at topping	1550	91.37	1417	86	2.24	58
3. Maleic hydrazide before topping	1704	90.24	1538	98	0.18	11
4. Contact	1572	91.39	1440	70	4.33	81
5. Contact before topping maleic hydrazide at topping	1656	90.50	1499	99	0.13	4
Between Dates of Harvest						
August 18, 1975	1567	92.21	1447		1.58	56
August 28, 1975	1550	89.99	1393		7.16	86

The Feasibility of Transplanting Tobacco Seedlings in Pressed Peat-Soil Cubes

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Purpose and Objectives

The purpose of this research was to develop new methods of growing tobacco plants which would have a potential for reducing the high labor requirements associated with transplanting. The peak labor demand at transplanting is a major problem in tobacco production. Irregular tobacco at harvest time because of non-uniform transplants is a critical problem in the total mechanization of tobacco production. Non-uniformity is caused in part by severe shock at transplanting because most of the seedling's roots are broken-off in the "pulling" process. This work offers an opportunity of improving seedling uniformity which would be an advantage in a mechanization program.

The objectives of this study were:

1. To compare the early growth and uniformity of transplants in pressed peat-soil cubes and transplants with various sizes of intact root systems to conventional transplants.
2. To compare the yield, price per hundredweight and acre value of cured tobacco from pressed peat-soil cubes and transplants with various sizes of intact root systems to conventional transplants.

Procedure

This experiment was located on a Monmouth sandy loam soil at the Tobacco Experimental Farm. Md. 201 variety was transplanted using a hand transplanter at a plant population of 6,223 per acre. Fertilizer was broad-

cast at a rate of 60-120-180 lbs. per acre. Experimental design was a randomized complete block with 4 replicates. Plots were 1-row of 27 plants or 3 by 63 ft. in size with 25 plants harvested.

There were five treatments including a control which consisted of conventional transplants pulled from a plant bed and selected according to uniformity of size and shape. The second treatment was a plant with an intact root system which was grown in a pressed peat-soil cube with a root system volume of 6.13 cu. in. The three remaining treatments were plants grown in plastic containers with root system volumes of; 5.20 cu. in., 10.00 cu. in. and 20.93 cu. in., respectively. The growing medium for the four treatments with intact root systems was a mix by volume of 50% peat, 20% soil, 20% vermiculite and 10% perlite.

Transplanting was carried out on May 27, 1975. This period was one of adequate rainfall and soil moisture was at an optimum level. Harvesting was completed on August 1, 1975.

Ratings of early growth rate or size were made on July 2, 1975 by three observers on a 1 to 10 basis with 10 being the largest. Ratings of relative uniformity based on plant to plant variation within individual plots were made at the same time with 10 being the best plot. Yield per acre, price per hundredweight and acre values of the cured tobacco were also determined.

Results and Discussion

Field results are presented in Table 1. The early growth ratings indicated that the seedling with the largest root system (20.93 cu. in.) grew significantly faster than either the cube-seedling (6.13 cu. in.) or the seedling from the medium sized plastic container (10.00 cu. in.). All intact root system treatments were superior to the control. Uniformity ratings showed that the control was less uniform than the other treatments.

Yield per acre for all treatments with intact root system was higher than the yield of the control. There were no yield differences among the four intact root system treatments. Price per hundredweight was the same for all treatments. Dollar value per acre was over $340 higher for the various intact root system treatments than for the control. There were no differences in acre values among the four intact root system treatments.

Soil moisture conditions during this season favored the intact root system treatments because of fast early growth. Soil moisture was ideal at transplanting but rainfall was deficient from planting until July 11 when 7.13 inches fell in a four-day period. This dry spell prevented the optimum development of the control treatment and resulted in the low yield.

Summary

Four treatments consisting of seedlings with different volumes of intact root system and a conventional transplant were compared in performance of tobacco yield per acre, price per hundredweight, acre value, uniformity rating and early growth rate.

The intact root system treatments grew at a more rapid rate and were more uniform than the control treatments. The yield per acre and acre value were higher for the intact root system treatments than the control treatment. There were no differences in yield or acre value among the various volumes of intact root system treatments.

Table I. Yield, price per hundredweight, acre value, uniformity and growth ratings of various types of tobacco transplants, 1975.

Treatment	Yield lbs/A	Price $/cwt.	Value $/A	Uniformity rating	Early Growth rating
5.20 cu. in.	1943	89.84	1747	9.50	6.00
10.00	1863	90.04	1678	9.00	5.75
20.93	1958	90.07	1765	9.25	7.00
6.13	1886	90.22	1700	9.75	5.75
Control	1468	91.00	1337	7.75	2.00
Average	1824	90.23	1645	9.05	5.30
L.S.D. (.05)	264	N.S.	229	1.12	1.02
(.01)	370	N.S.	322	N.S.	1.44
C.V. (%)	9.4	1.2	9.1	8.0	12.6

Effect of Nitrogen on Tobacco Performance and Correlations of Total Nitrogen Analysis With Tobacco Yields

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Purpose and Objectives

Tobacco plant growth is influenced to a greater degree by nitrogen than any other fertilizer material. In fact nitrogen is the most important factor under control of the average grower influencing tobacco yields.

The correct availability of nitrogen to the plant is critical. Nitrogen deficiency results in low yields, pale-color and poor tobacco quality. Too much nitrogen gives a slow maturing leaf which often cures with greenish colors, is high in alkaloid and protein content and has objectionable smoking taste.

The Soil Testing and Plant Analysis Program of the University of Maryland offers growers an opportunity to have a plant analysis made of his crop and this is a potential means of checking the nitrogen status of tobacco during growth. Although plant analysis is available to the growers of Southern Maryland, information is needed on sampling procedure and interpretation of the laboratory results. Although plant analysis is offered for most plant nutrients, this preliminary report will deal only with the critical N content of tobacco leaves.

The objectives of this work were:

1. To determine the effect of various rates of N on tobacco yields, price per cwt., value per acre and filling capacity (specific volume).

2. To investigate variation of total N with leaf position and stage of plant growth at time of sampling.

3. To determine correlations of yield per acre at the different N levels with total N content of the various leaf samples.

Procedure

The location of this experiment was the University of Maryland Tobacco Experimental Farm near Upper Marlboro. The soil was a Monmouth fine sandy loam. The variety Md. 10 was transplanted at a population of 6223 plants per acre with 0-120-180 ($N-P_2O_5-K_2O$) lbs. of tobacco fertilizer broadcast per acre. The nitrogen variable was supplied at rates of 0, 30, 60, 120 and 240 lbs. per acre, respectively, of nitrogen with ammonium nitrate used as the source of nitrogen material. Nitrogen was applied by sidedressing on the day of transplanting, June 6, 1974. Four replicates were used in a randomized complete block design. Individual plots contained 4 rows 37 ft. long and spaced 3 ft. apart. The two middle rows were harvested from each plot on August 30, 1974.

Leaf samples were taken for total nitrogen analysis as follows: sample 1 — when plant was at the knee-high stage of growth and the uppermost leaf of 10 inch length was taken from 10 plants at random. This was approximately the 8th leaf from bottom of stalk.; sample 2 — when plant was in the pre-flower stage and the 8th leaf from bottom of stalk was taken from 10 plants at random; sample 3, 4 and 5 — when plant was completely cured and approximately the 10th, 13th and 16th leaf from bottom of stalk, respectively, was taken. These samples were analyzed for total nitrogen in the Soil Testing and Plant Analysis Laboratory of the University of Maryland.

Cured leaf data was recorded for yield and value per acre, and price per cwt. Filling capacity, an index of the number of cigarettes a given weight of tobacco will fill was determined by the standard method. Correlation coefficients were calculated between acre yields and the various determinations of total leaf N.

Results

Table I presents the results of tobacco performance and the plant analysis for total nitrogen taken at different growth stages and various leaf positions.

Yield per acre was relatively low at the 0 N-rate as would be expected. The higher nitrogen rates of 120 and 240 lbs. per acre resulted in greater yields. The yield at the 240 lb. N-rate was 818 lbs. per acre higher than the 0 lb. N-rate. Quality as indicated by price per hundredweight was inferior at the 240 lb. N-rate. The 0, 30 and 60 lb. N-rates resulted in prices that were not significantly different but the 120 lb. N-rate showed a trend of lower quality. Dollar value per acre was largely controlled by the yield with a general trend upward indicated for increased N-rates. The filling capacity decreased consistently for each addition of nitrogen.

The leaf analysis for total N indicated high correlation coefficients between tobacco yield per acre and total N. The highest correlation coefficient among the various leaf samples occurred at the 16th leaf position of the cured sample which was the most immature leaf sampled. The lowest correlation coefficient appeared at the pre-flower sampling which was the most mature leaf sampled.

Summary

Preliminary results were obtained upon the effect of nitrogen applications on tobacco performance and correlations were determined for total leaf nitrogen with tobacco yields. Nitrogen rates included 0, 30, 60, 120 and 240 lbs. per acre of actual nitrogen. Total nitrogen in the leaf samples was determined to investigate its variation with leaf position and stage of plant growth. Tobacco yield per acre increased with additional increments of nitrogen. Quality as indicated by price per hundredweight was lower for the 240 lb. N-rate. Value per acre showed increases with added increments of nitrogen. Results of the 1974 tests indicated a high correlation coefficient between yield per acre and total leaf nitrogen. The correlation coefficients tended to be higher with the more immature leaves sampled.

Table 1. Effect of fertilizer N on tobacco performance and total N content of certain selected leaves. 1974.

Nitrogen Treatment lbs/A	Yield lbs/A	Price/Cwt.	Acre Value $/A	Filling Capacity cc/gm	Per Cent Total N				
					Knee-High 8th leaf	Pre-Flower 8th leaf	Cured 10th leaf	Cured 13th leaf	Cured 16th leaf
0	1457	82.87	1207	6.25	1.88	2.65	2.35	2.83	3.23
30	1690	83.40	1409	6.20	1.75	2.50	2.60	3.53	3.35
60	1660	82.88	1375	6.05	3.13	2.90	2.85	3.33	3.50
120	1961	81.48	1597	5.78	3.50	3.55	3.03	3.93	4.30
240	2275	79.37	1812	5.43	3.88	3.53	3.48	4.63	4.88
Mean	1808	82.00	1480	5.94	2.83	3.03	2.86	3.65	3.85
L.S.D. (.05)	280	1.96	239	0.52	0.94	0.82	0.39	0.41	0.55
(.01)	392	2.77	336	N.S.	1.32	N.S.	0.54	0.57	0.77
C.V. (%)	10.1	1.6	10.5	5.7	21.5	17.5	8.8	7.3	9.3
					+ 0.85*	+ 0.51*	+ 0.83*	+ 0.84*	+ 0.91*

* Correlation coefficient between yield per acre and total N.

Regional Tests With Tobacco Sucker Control Agents on Maryland Tobacco

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Purpose and Objectives

Plant growth regulators have been used to inhibit the growth of tobacco suckers in all types of tobacco. However, some undesirable effects on the chemical and physical properties of the tobacco and possibly the health of consumers have been suggested. Consequently, studies have been going on for some time on a regional basis to find other chemicals and methods of sucker control which would be more suitable. (This approach has been through the Regional Tobacco Growth Regulator Committee which involves 10 states, U.S.D.A., EPA, many chemical companies, most of the domestic tobacco companies and one foreign tobacco company.)

Maryland is a participant in this regional research and the report herein will deal with 1975 results in Maryland to determine the effectiveness of several sucker control agents on tobacco yield, price, acre values and sucker control.

Procedure

The experiment was conducted on a Monmouth fine sandy loam at the Tobacco Experimental Farm. Md. 10 variety was transplanted on June 4, 1975 with 60-120-180 lbs. of fertilizer broadcast per acre. Four replicates were used in a randomized complete block design. Topping was completed on August 4 when 70% of the plants showed at least some open flowers. Suckers were removed after 14 days, counted and weighed. The control treatment which was not suckered served as a basis for calculating the percent sucker

control. Treatments studied were: topped unsuckered control, maleic hydrazide (Uniroyal), Off-Shoot-T (Procter and Gamble), FST-7 (Fairmount), TD-6266 R and TD-6817 (Armak) and CGA-16327 (Ciba-Geigy). Sucker control treatments were applied immediately after topping on August 4, 1975. Harvesting was completed on August 19, 1975.

Results

Control of suckers was satisfactory for all chemicals used as suckering agents when compared to the untreated control. Off-Shoot-T, FST-7 and CGA-16327 resulted in control of 95 per cent or better. Maleic hydrazide, TD-6266 R and TD-6817 gave 80, 86 and 81 per cent control, respectively. Yield and acre value were highest where Off-Shoot-T was used as the suckering agent. Lowest yield and acre value were obtained for the control and FST-7 treatments. There were no leaf injury symptoms observed for any of the treatments in 1975. Phytotoxic effects frequently occur with the use of some suckering agents.

Summary

Regional sucker control tests were conducted on Maryland tobacco to determine the effectiveness of various suckering agents on degree of sucker control, yield, price and acre values of tobacco. All of the suckering materials gave better results than the untreated control. Off-Shoot-T, FST-7 and CGA-16327 resulted in 95 per cent or better sucker control. The remaining chemical treatments ranged from 80 to 86 per cent control when compared to the control treatment. There were no important differences in price per hundredweight for tobacco from any of the treatments including the control treatment; however, a higher yield and acre value resulted from the Off-Shoot-T treatment.

Table 1. The effects of tobacco sucker control treatments on yield, price per hundredweight, acre value and sucker growth. 1975.

Treatment	Cured Leaf			Sucker Growth		
	Yield lbs/A	Price $/cwt.	Acre Value $/A	Sucker Control %	Weight gms/plant	Suckers no./plant
Control	1632	99.13	1618	0	281	11.2
MH-30	1671	98.88	1652	80	56	10.0
Off-Shoot-T	1800	97.01	1747	95	13	0.5
FST-7	1643	95.92	1576	97	10	0.5
TD-6266 R	1691	98.52	1666	86	40	8.8
TD-6817	1718	99.33	1707	81	54	9.7
CGA-16327	1712	96.47	1652	97	8	0.9

Performance of Barley Varieties and Breeding Lines in Maryland, 1975

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Purpose and Objectives

Variety trials are necessary to evaluate new and presently grown varieties under Maryland's environmental conditions. Advanced breeding lines are also evaluated which have potential as a new variety. The information obtained from these trials provides a dependable guide for varietal selection.

Procedures

In 1975 performance trials were conducted at four locations with varying soil types. Two of these locations are on the Eastern Shore - Queenstown on a Mattapex silt loam and Quantico on a Galestown sandy loam. The other two locations are west of the bay at Clarksville on a Manor silt loam and Hagerstown on a Hagerstown loam.

Four replications of a randomized complete block design were used at each location. Each plot consisted of two rows, 10 feet long and 1 foot apart. Management practices were used in accordance with those normally accepted for the production of barley. Fourteen standard varieties and four advanced breeding lines were evaluated at all locations.

Results

Barley results are reported in Table 1. The average performace of the varieties revealed that Va 72-44-362 was the superior line, yielding 68.5 bushels per acre. Va 72-44-362 was released in 1975 as Henry by the Virginia Agricultural Experiment Station. Barsoy is no longer the leading variety, particularly on the Eastern Shore. However, west of the bay Barsoy has not shown any substantial reduction in yield. Rapidan and Volbar were the high-

est yielding varieties on the Eastern Shore with yields of 64.3 and 61.9 bushels per acre, respectively. The leading varieties for yield in the state were Knob, Hanover, Volbar, Barsoy and Rapidan in 1975. Test weights were also low this year due to scab and glume blotch.

Summary

Several new varieties will be available for farmers next year. Surry (Va 72-11-18), Monroe (Va 72-44-565) and Henry (Va 72-44-362) have been released by the Virginia Agricultural Experiment Station. These varieties have excellent disease resistance and lodging resistance.

Table 1. Average performace of barley for several characteristics in Maryland, 1975.*

Entry	Yield Bu/A	Test Wt. lbs/Bu	Date Headed	Percent Lodging	Height Inch
+Va 72-44-362	68.5	42	May 8	33	37
Knob	68.1	42	May 7	35	37
Hanover	65.4	40	May 8	36	39
+Va 72-11-18	65.0	42	May 7	36	39
Volbar	64.8	43	May 11	36	42
Barsoy	62.4	45	May 1	48	36
Rapidan	61.8	39	May 8	43	36
+Va 72-44-525	59.5	39	May 12	25	35
McNair 601	59.4	42	May 5	36	39
+Va 70-44-213	58.0	41	May 11	37	37
Harrison	57.8	46	May 12	30	38
Tschermak	56.5	48	May 10	48	43
Kamiak	55.8	41	May 10	48	36
Jefferson	52.5	42	May 11	32	39
Pennrad	51.8	40	May 12	51	42
Lakeland	50.1	44	May 15	40	37
Wong	49.6	40	May 12	45	42
Nebar	41.2	46	May 13	43	39
Grand Mean	57.2				
LSD	7.6				

* Average of Queenstown, Quantico, Clarksville, and Hagerstown data.

+ Advanced breeding line.

Performance of Wheat Varieties and Breeding Lines in Maryland, 1975

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Department of Agronomy

Purpose and Objectives

Variety trials are necessary to evaluate new and presently grown varieties under Maryland's environmental conditions. Advanced breeding lines are also evaluated which have potential as a new variety. The information obtained from these trials provides a dependable guide for varietal selection.

Procedures

In 1975 performance trials were conducted at four locations with varying soil types. Two of these locations are the Eastern Shore - Queenstown on a Mattapex silt loam and Quantico on a Galestown sandy loam. The other two locations are west of the bay at Clarksville on a Manor silt loam and Hagerstown on a Hagerstown loam.

Four replications of a randomized complete block design were used at each location. Each plot consisted of two rows, 10 feet long and 1 foot apart. Management practices were used in accordance with those normally accepted for the production of wheat. Thirteen standard varieties and five advanced breeding lines were evaluated at all locations.

Results

The average performance of the wheat varieties at all locations is presented in Table 1. Wheat yields were low because of scab (*Gibberella zea*). This is the same fungus that causes Gib ear rot of corn. High humidities and temperatures occurred at pollination, producing a most favorable environment for infection. Test weights were generally low because of scab infection and glume blotch (*Septoria nodorum*). Potomac, a new release by

the Maryland and Virginia Experiment Stations, was the highest yielding variety (50.8 Bu/A). Potomac wheat has good resistance to powdery mildew and leaf rust. The grain has excellent test weight, similar to Arthur. The Virginia breeding line, Va 70-50-22, yielded the highest with 56.1 bushels per acre; however, the test weight was very low, similar to Blueboy. Abe, Arthur and Arthur 71 had similar yields on the Eastern Shore. Considerable amounts of lodging were recorded west of the bay.

Summary

The Maryland and Virginia Agricultural Experiment Stations have released a high-yielding variety under the name Potomac. Registered seed will be available in limited supplies in 1976.

Table 1. Average performace of wheat varieties for several characteristics in Maryland, 1975.*

Entry	Yield Bu/A	Test Wt. lbs/Bu	Date Headed	Percent Lodging	Height Inch
+ Va 70-52-22	56.1	55	May 22	31	35
Potomac	50.8	57	May 21	31	35
Redcoat	47.6	57	May 23	31	43
McNair 1813	47.4	57	May 18	33	40
+ Coker 73-18	46.2	59	May 14	34	34
Coker 68-15	46.1	58	May 17	37	36
+ Coker 74-27	45.9	57	May 19	37	34
+ Coker 73-23	44.6	57	May 17	45	42
Blueboy	44.6	55	May 22	23	38
+ Va 68-24-42	44.3	55	May 22	31	37
McNair 701	43.8	53	May 16	41	39
McNair 4823	43.3	57	May 22	30	37
Abe	43.3	56	May 18	41	37
Holley	42.2	56	May 15	45	41
Blueboy 11	40.2	54	May 22	37	40
Arthur 71	39.3	57	May 18	40	45
Oasis	39.3	57	May 21	36	39
Arthur	38.1	57	May 18	43	40
Grand Mean	44.6				
LSD	5.1				

* Average of Queenstown, Quantico, Clarksville and Hagerstown data.
+ Advanced breeding lines.

A Comparison Between Weak Acid and DTPA Extractable Soil Cd, Cu, Ni, and Zn from Three Metal Salt Amended Maryland Soils

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Purpose and Objective

The use of chemical extractants to estimate the plant availability of a particular nutrient is a well established practice. However, information concerning the utilization of chemical soil extractants in estimating plant availability of cadmium, copper, nickel, and zinc, particularly at excessive levels, is scant for Maryland soils.

The current investigation is a portion of a larger research program aimed at evaluating the fate of cadmium, copper, nickel, and zinc in a range of Maryland soils. The objective in this study was to compare the soil extractability of cadmium, copper, nickel, and zinc using two chemical extractants and to observe how each correlated with plant uptake of these metals.

Procedures

Three soils, Sassafras loamy sand, Collington loamy sand, and Manor sandy loam were selected from a broader range of soils currently being used in a greenhouse study of the fate of applied Cd, Cu, Ni, and Zn. Only the Ap horizon samples of the three soils were employed. In brief, the larger study was set up using metal-equivalent additions of metal salts based on the amounts of metals that would have been applied by a range of Blue Plains sewage sludge additions to the soils. If the sewage sludge had been used, it would have contained 2068, 786, 69.1 and 20.0 ug/g dry sludge of Zn, Cu, Ni, and Cd, respectively. The actual amounts of metals applied would have been those added if 0, 6.25, 25, and 100 dry T/A additions of the sludge had been used on low cation exchange capacity soils (Sassafras). For higher cation

exchange capacity soils (Collington and Manor), the metals added would have been those present in 0, 25, 100, and 400 dry T/A additions of the sludge.

Two pH regimes were maintained, natural field pH and limed to pH 6.5 by preparing lime curves for each soil. The field pH's were 5.1, 5.9, and 5.6 for the Sassafras, Collington, and Manor soils, respectively. Appropriate macro- and micronutrients were applied to the pots for good corn growth. Fertilizers and metal salts were mixed with the soil, watered and allowed to equilibrate for 30 days prior to planting. Corn (Pioneer 3369-A) was then planted on the soils and harvested 30 days after emergence. The data presented represent the plant and soil samples taken after the first corn growth period, which was 60 days after the pots were initially mixed (after metal salt addition) and watered.

Extractable soil, Cd, Cu, Ni, and Zn were determined by the DTPA (diethylenetriaminepentaacetic acid buffered at pH 7.3) and weak acid (0.05 N HCl plus 0.025 N H_2SO_4) extractants. Thirty ml of DTPA solution were added to appropriate samples of soil, shaken for two hours, filtered, and the filtrate analyzed for metals. For the weak acid procedure, 20 ml of solution was added to appropriate samples of soil, shaken for five minutes, filtered and the filtrate analyzed for metals. The weak acid procedure is essentially the same as that used by the University of Maryland Soil Test Laboratory for routine soil analysis. Plant tissue was dry ashed and the residue taken into solution by 6N HCl, diluted and analyzed. All elemental determinations were performed by atomic absorption spectrophotometry.

Correlation analyses of the data were made on the combined limed and unlimed soils.

Results and Discussion

The coefficients of determination (r^2) between plant metal uptake and each of the two extractants are shown in Table 1. In all but one comparison,

Cd from the Manor soil, the DTPA extractant produced higher r^2 values than weak acid with plant metal uptake. Cadmium soil-plant correlations were consistently higher for all soils than any other metal. Coefficients of determination for copper, nickel, and zinc were sporadic depending upon soil. Of particular interest are the low r^2 values for nickel and zinc from the Collington soil independent of extractant. Extractable zinc from the limed Collington soil, pH 6.5, was higher than the unlimed, pH 5.9, soils (See Fig. 1) while plant zinc uptake decreased with liming. The extractable Zn results were contrary to the usually cited decrease in zinc extractability with increased pH, however, the plant did respond in the expected manner. The poor r^2 values for Ni from the Collington soil plus the other relatively low r^2 values in Table 1 point out one of the inherent problems in utilizing coefficients of determination at excessive soil-plant-metal levels. At excessive metal levels in the soil, which can induce phytotoxic conditions, the plant may no longer exhibit predictable metal uptake patterns due to physiological imbalances. The phytotoxicity of a metal may occur at the plant root, as in the case of copper, with little or erratic translocation to the above-ground portion. These effects plus possible interactions between the metals may account for the lower r^2 values recorded in Table 1.

Coefficients of determination (r^2) values and regression equations between weak acid and DTPA extractable soil metals are shown in Table 2. The regression equations indicate that the DTPA extractant consistently extracted smaller amounts of metals independent of soil type. In general, good agreement was obtained between the two extractants for extractable Cd, Cu, and Zn independent of soil type. The agreement between extractants for Ni was somewhat lower over all soil types.

Summary

The weak acid and DTPA soil extractants were compared using three soils

amended with a range of metal salts and under two pH regimes. DTPA gave higher coefficients of determination (r^2) when correlated with plant uptake of cadmium, copper, nickel and zinc by corn. Numerically low r^2 values were probably due to plant physiological imbalances due to phytotoxic conditions caused by excessive metal additions. The weak acid extractant resulted in higher extractable metal values than DTPA. Good agreement was obtained between the two extractants for Cd, Cu, and Zn while Ni was somewhat poorer.

Table 1. Coefficients of Determination (r^2) between plant metal content and extractable soil metals as determined by the DTPA or weak acid extractant.

Soil	Metal							
	Cadmium		Copper		Nickel		Zinc	
	Extractant[1]		Extractant		Extractant		Extractant	
	DTPA	W.A.	DTPA	W.A.	DTPA	W.A.	DTPA	W.A.
Sassafras	.9205**[2]	.9136**	.1718*	.1541 ns	.7278**	.4614**	.5535**	.5338**
Collington	.8945**	.8748**	.6457**	.5514**	.2052*	.0000 ns	.0475 ns	.0266 ns
Manor	.8770**	.9037**	.8817*	.7057*	.3706**	.2426*	.5295**	.3914**

[1] DTPA denotes diethylenetriamine pentaacetic acid buffered at pH 7.3 and W.A. denotes the weak acid extractant - 0.05 N HCl + 0.025 N H_2SO_4

[2] Statistical significance of the values where: ns = nonsignificant; * = significant at the 5% level; and ** = significant at the 1% level.

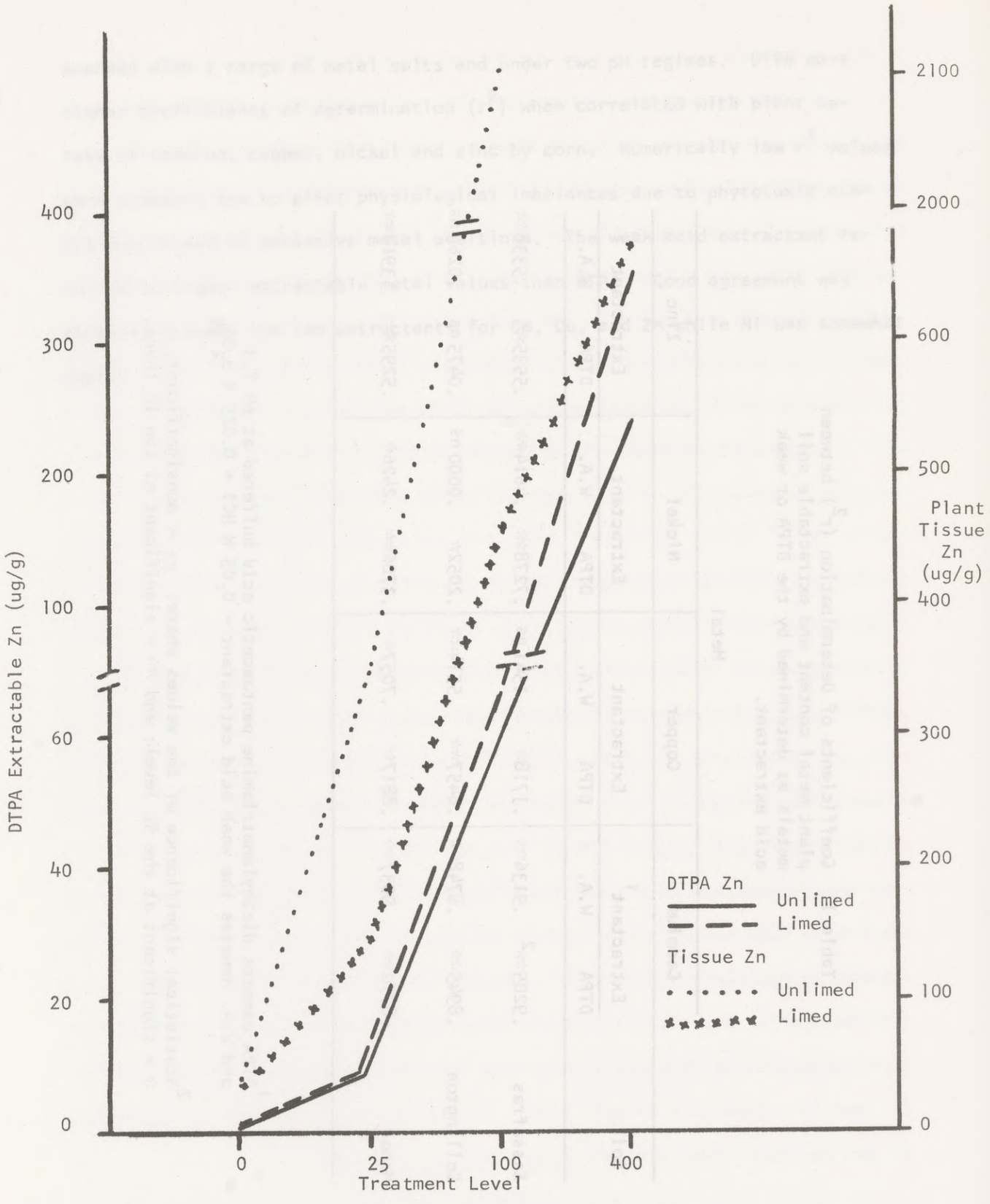

Fig. 1 DTPA extractable soil zinc and plant tissue zinc from the limed and unlimed Collington soil.

Table 2. Coefficients of determination (r^2) and regression equations between weak acid (Y) and DTPA (X) extractable soil Cd, Cu, Ni, and Zn from three soils amended with metal salts under unlimed and limed conditions.

Soil	Extractable Cd		Extractable Cu		Extractable Ni		Extractable Zn	
	r^2	reg. eq.	r^2	reg. eq.	r^2	reg. eq.	r^2	reg. eq.
Sassafras	.9611**[1]	Y=-0.00+1.35(X)	.9955**	Y=0.07+1.56(X)	.8484**	Y=0.13+1.05(X)	.9686**	Y=3.80+1.34(X)
Collington	.9745**	Y=-0.04+1.84(X)	.9252**	Y=1.06+1.71(X)	.5740**	Y=0.23+2.49(X)	.9376**	Y=7.59+2.00(X)
Manor	.9504**	Y=0.08+1.36(X)	.8910**	Y=6.72+1.51(X)	.4331*	Y=1.72+1.33(X)	.5960**	Y=35.31+1.55(X)

[1] Statistical significance of the values where: * = significant at the 5% level; and ** = significance at the 1% level.

Utilization of Composted Sewage Sludge in a Forest Tree Nursery: A Field Study

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Purpose and Objectives

This research is being performed in collaboration with the project leader, Dr. F.R. Gouin of the Horticulture Department, in order to evaluate the utilization of composted sewage sludge in a forest tree nursery situation. This represents a unique application for the utilization of composted sewage sludge since the forest tree nursery stock will be grown under these circumstances for one to two seasons, depending upon species, and then removed.

The objective of this phase of the research project is to quantitatively measure and monitor with time the zinc, copper, nickel and cadmium levels in the soil, millet cover crop and subsequently the nursery stock seedlings.

Procedures

The experiment is located at the Buckingham State Forest Nursery in Glen Burnie, Maryland on a Galestown loamy sand to sandy loam soil. The plots were arranged in a randomized complete block design consisting of four replications with six treatments per replicate giving a total of 24 experimental units. The composted sludge rates were 0, 25, 50, 100 and 200 dry tons per acre with an additional treatment receiving no sludge but the recommended rates of inorganic fertilizer and lime (0^+). The composted sewage sludge was obtained from the Beltsville sewage compost site which utilizes sewage sludge from the Blue Plains Treatment Facility in Washington, D.C. Wood chips, mixed in for composting, were screened out prior to application of the compost.

The following list provides the pertinent dates for sludge addition

and soil and plant sampling.

May 5, 1975	(Time 1)	Background soil samples collected.
May 14, 1975	(Time 2)	Soil samples taken at conclusion of compost application.
July 31, 1975	(Time 3)	First sampling of millet cover crop-uppermost fully developed leaf, soils also sampled.
Sept. 4, 1975	(Time 4)	Second sampling of millet cover crop-sampled uppermost fully developed leaf, soils also sampled.
Oct. 9, 1975	(Time 5)	Soil samples taken prior to tree seeding.
Dec. 18, 1975	(Time 6)	Soil samples collected.

The extractable soil heavy metals were estimated by the pH 7.3 DTPA (diethylenetriaminepentaacetic acid) extractant. Total metals in the sewage sludge compost were determined by dry ashing, followed by dissolution by 0.5 N HCl. Soil pH was measured on a 1:1 soil to water ratio equilibrated for one hour. The millet cover crop tissue was dried, ground and then dry ashed and finally brought into solution using 0.5 N HCl.

The data obtained have been statistically analyzed as a split-plot design with replications as the main plots, treatments as the sub-plots and time as the sub-treatment.

Results and Discussion

The total and DTPA extractable metals from six composite samples of the composted sewage sludge are presented in Table 1. From the recorded values it can be calculated that the 100 dry ton per acre treatment would apply 431, 103, 38.4 and 2.8 pounds per acre of total zinc, copper, nickel and cadmium, respectively to the soil.

The changes in soil pH as effected by compost addition and time are shown in Table 2. There was a significant ($p < 5\%$) treatment-time interaction indicating that the effect of time over treatments is not consistent. Generally, increasing compost application increased soil pH.

However, no explanation is readily available for the pH increase with time on the 0 treatment plots which received no compost, fertilizer, or lime.

Measuring the plant availability of the heavy metals in the soil, estimated by the DTPA extractant, over time is of importance. Such measurements may indicate that the metals are "reverting" to unavailable forms with time hence becoming less hazardous to plants.

The DTPA extractable soil zinc, nickel and cadmium levels from all treatments and over the six sampling periods are presented in Table 3. Statistically, a significant treatment-time interaction ($p < 1\%$) occurred for each of the four metals, again indicating that the effect of time over treatments was not consistent. This interaction is exemplified by the extractable zinc values recorded in Table 3. At the 25 T/A compost treatment, extractable zinc increased at time two due to the addition of compost and then falls off to a steady-state value of approximately 8 ug Zn/g soil for the following four time periods. The 200 T/A compost addition produced, as expected, a higher extractable zinc level at time two but a steady-state level was not reached until the fifth sampling period. In general, the following can be noted from the data in Table 3. Extractable zinc decreases with time and may approach a steady-state for each treatment. Extractable copper, nickel, and cadmium show more erratic trends, particularly since they did not show maximum extractability at the initial sampling when compost was applied (Time 2). Overall, the extractability of all the metals is further complicated by the general increase in soil pH (see Table 2), since metal extractability generally decreases with increasing pH. However, from Table 2, the pH of the compost amended soils may be declining (note Time 6 vs. Time 5) and this decrease is not reflected in

a general increase in extractability of the metals (compare Time 6 vs. Time 5 in Table 3). These trends will be studied in further samplings.

During the summer immediately following the compost additions, pearl millet was grown on the plots as a cover crop since forest nursery stock is not seeded until the fall. The millet was sampled twice and the zinc, copper, nickel and cadmium contents of the uppermost fully developed leaves were measured (Table 4). Sludge compost additions resulted in slight increases of the metals in the millet tissue but all values are within the normal ranges cited in the literature.

Summary

The addition of composted sewage sludge to forest tree nursery plots has been monitored with respect to extractable soil heavy metals and their uptake by a pearl millet summer cover crop. The addition of composted sewage sludge seemed to have a liming effect on the soil which lasted approximately six months. In general, DTPA extractable soil zinc, copper, nickel and cadmium decreased with time after the addition of the composted sewage sludge, probably because of the increased pH. The pearl millet cover crop contained normal amounts of zinc, copper, nickel and cadmium when grown in plots containing up to 200 tons per acre of composted sewage sludge. The experimental area will be monitored further to follow the fate of the compost borne metals in the soil and their effect on the fall seeded forest tree nursery stock.

Acknowledgements

Appreciation is expressed to the Computer Science Center of the University of Maryland for the computer time utilized in analyzing the data.

Table 1. Average total and DTPA extractable heavy metal content of six composite samples of composted sludge taken during compost application.

Parameter	Metal			
	Zinc	Cooper	Nickel	Cadmium
	ug/g			
DTPA Extractable	446±13.0	108±22.1	11.2±0.72	4.5±0.51
TOTAL	2154±83.0	517±14.0	92±8.00	13.9±0.50

Table 2. Effect of the application of composted sewage sludge to forest tree nursery plots and time on soil pH.

	Treatment					
Time*	0	0 + 1/	25	50	100	200
1	5.4**	5.6	5.7	5.5	5.6	5.6
2	5.6	5.5	5.7	5.7	6.0	6.2
3	6.0	6.0	6.0	6.2	6.3	6.4
4	6.2	6.2	6.4	6.5	6.6	6.7
5	6.2	6.3	6.4	6.5	6.8	7.0
6	6.2	6.4	6.2	6.4	6.6	6.8

*For description of various sampling times, see Procedures Section.
**All values are averages of four replications.
1/Soils received recommended fertilizer additions but no sludge.

Table 3. Plant availability of DTPA extractable zinc, copper, nickel and cadmium in the forest tree nursery plots amended with composted sewage sludge.

Time*	Treatment (T/A Compost) 0	0+1/	25	50	100	200
	ug/g					
	DTPA Extractable Soil Zinc					
1	2.4**	2.6	2.2	2.5	2.8	2.2
2	2.0	2.0	33.9	34.2	67.1	113.8
3	1.9	1.6	8.3	30.2	28.6	110.9
4	1.6	1.5	7.5	13.9	33.2	118.6
5	2.0	1.9	8.6	15.2	27.1	59.4
6	3.3	2.1	8.2	15.6	27.5	56.6
	DTPA Extractable Soil Copper					
1	1.6	1.7	1.6	1.5	1.6	2.0
2	1.6	1.7	2.9	2.5	4.4	6.8
3	1.5	1.5	3.9	10.5	11.8	32.9
4	1.4	1.4	3.6	6.2	13.0	42.7
5	1.2	1.3	3.6	6.1	10.5	22.4
6	2.2	1.8	4.0	6.4	11.0	21.2
	DTPA Extractable Soil Nickel					
1	0.5	0.5	0.4	0.4	0.5	0.5
2	0.5	0.5	0.5	0.4	0.5	0.7
3	0.4	0.4	0.7	1.5	1.0	2.7
4	0.5	0.4	0.6	0.7	1.3	4.4
5	0.3	0.3	0.6	0.4	0.8	1.9
6	0.1	0.2	0.2	0.8	1.4	2.2
	DTPA Extractable Soil Cadmium					
1	0.03	0.02	0.02	0.03	0.03	0.04
2	0.02	0.02	0.08	0.06	0.16	0.22
3	0.02	0.02	0.08	0.33	0.35	1.07
4	0.03	0.03	0.11	0.13	0.38	1.37
5	0.01	0.01	0.08	0.14	0.30	0.72
6	0.04	0.03	0.10	0.17	0.32	0.72

*For description of various sampling times see Procedures Section.

**All values are averages of four replications.

1/ Soils received recommended fertilizer additions but no sludge.

Table 4. Tissue zinc, copper, nickel and cadmium content from the two samplings of the millet summer cover crop.

Element	Time*	Treatment (T/A compost) 0	0+ 1/	25	50	100	200
		ug/g tissue					
Zinc	3	60a**	56a	51a	64a	58a	57a
	4	47a	56ab	62ab	64b	70bc	81c
Copper	3	6.6a	7.8ab	7.2a	10.3d	8.7bc	9.5cd
	4	5.2a	5.8a	5.4a	5.7a	5.6a	6.1a
Nickel	3	4.5a	4.9a	4.6a	5.2a	5.9a	5.4a
	4	0.2a	0.5ab	0.9abc	1.6bcd	1.8cd	2.3d
Cadmium	3	0.8ab	0.6a	0.9ab	1.1b	1.1b	1.5c
	4	0.3a	0.4a	0.6ab	0.8bc	1.1c	1.6d

*For description of various sampling times see Procedures Section.

**All values are averages of four replications. Values within the same row followed by the same letter are not statistically different at the 5% level according to Duncan's Multiple Range Test.

1/Soils received recommended fertilizer additions but no sludge.

Movement of NaCl Through the Soil

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Purpose and Objectives

The first of two cooling towers at the Chalk Point Power Plant began operations in the spring of 1975, the second cooling tower is scheduled to begin operations by 1980. The cooling towers, which use brackish water, will be dispersing salts into the atmosphere. These salts will ultimately be deposited on the surrounding crops and soils. From early plume dispersion models, a maximum deposition rate of 20 g per square meter per month was predicted for each of the cooling towers. The objective of this experiment was to study the movement of NaCl through the upper 45 cm of three representative soils in the area to be affected by the Chalk Point Power Plant.

Procedure

Plots were established at research sites 6 and 3 miles north (6N, 3N) and 1 mile east (1E) of the Chalk Point Power Plant. The soil type at these sites are Sassafras loam, Sassafras sandy loam, and Lakeland loamy sand respectively. Each plot was 1.5x1.5 m and surrounded by 10 cm plastic edging to prevent runoff between plots. The existing vegetation was killed by herbicide application. Three replicate treatments of 0, 10, 20, and 100 g $NaCl/m^2$ were applied to a 1x1 m area in the center of each plot. Treatments were applied by dissolving the appropriate amount of NaCl in 550 ml of distilled water and spraying the 1 m^2 area with a hand sprayer. The NaCl was applied on 17 July, 20 August, and 1 November, 1974. Soil samples were taken at 0-15, 15-30, and 30-45 cm depths at approximately monthly intervals. The Na, K, Ca, and Mg content of the soil was determined from a 1N ammonium acetate extract at pH 7, and electrical conductivity (EC) was determined on a 1:5 soil-water extract.

Results

Table 1 presents the distribution of Na in the upper profile at site 6N, as influenced by time and NaCl applications. The 3N and 1E sites gave similar results, however, since they are sandier soils, the Na moved through their respective profiles at slightly faster rates. Only the 0-15 cm depth is shown for the control (0 NaCl) since there were small differences in the Na content at the three depths sampled.

The applications of NaCl could easily be detected at the 0-15 cm depth. The 15-30 and 30-45 cm depths showed increased Na two months after the initial NaCl application. Four months after the last NaCl application, the Na content of the 0-15 and 15-30 cm depths had decreased dramatically with no change in the 30-45 cm depth. Nine months after the last NaCl application the 0-15 cm depth contained 9 ppm more Na while the 15-30 and 30-45 cm depth contained 5 and 2 ppm more Na than the control.

Table 2 presents the electrical conductivity of the three soil depths at site 6N for the 0 and 20 g $NaCl/m^2$ treatments. The electrical conductivity followed a pattern similar to the Na content, with the 0-15 cm depth increasing in EC after a NaCl application, while the 15-30 and 30-45 cm depths increased one month after NaCl application. Two months after a NaCl application the 30-45 cm depth had a greater EC than the 15-30, indicating the salts were moving through the soil profile. Four months after the last NaCl application the upper 45 cm had returned to the same EC as that of the control.

The electrical conductivity measurement returned to the values of the control more quickly than did the Na values. This would be expected as the Na cation would be held on the exchange complex while the Cl anion moves through the profile with the water.

Summary

When NaCl was added to a Sassafras loam the Na cation moves very slowly through the upper soil profile. Nine months after the last 20 g/m^2 NaCl application, the electrical conductivity had returned to that of an unamended soil at all three soil depths; however, the Na content of the 0-15 cm depth was approximately twice that of an unamended soil while the Na content of the 15-30 and 30-45 cm depths were 56 and 22% greater than the control respectively. With normal rainfall to move NaCl through the soil, it would appear that Na could accumulate in the soil as a result of salt deposition at the rate of 20 g/m^2/ month from the cooling tower.

Acknowledgement

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Table 2. Electrical conductivity for 0 and 20 $NaCl/m^2$ treatments at three depths for Sassafras loam soil at site 6N.

Date of Sampling	NaCl added (g/m^2)					
	0			20		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
7-17 (NaCl added)	92±18[1/]	77±8	65±4	131±14	101±26	75±4
8-8	69±6	61±6	57±6	105±6	69±7	69±12
8-20 (NaCl added)	40±6	48±11	55±16	115±11	67±10	63±18
9-18	40±4	56±7	60±11	75±12	95±8	76±11
10-18	51±9	61±10	68±11	104±25	81±2	85±12
11-1 (NaCl added)	54±10	65±9	59±10	175±46	76±8	74±4
12-3	47±4	57±5	62±9	80±6	80±6	87±10
3-27	42±2	48±11	56±10	36±2	50±6	60±2
8-1	47±8	50±12	62±15	53±8	51±4	54±4

[1/] All values are means followed by ± one standard deviation.

Table 1. Distribution of Na in the upper 45 cm of a Sassafras loam at site 6N as influenced by NaCl application and time.

	NaCl added (g/m^2)			
	0	20		
Date of Sampling	0-15 cm	0-15 cm	15-30 cm	30-45 cm
7-17 (NaCl added)	7±2[1/]	31±10	25±13	8±1
8-8	8±1	41±4	12±2	7±1
8-20 (NaCl added)	8±2	77±17	14±3	14±6
9-18	8±2	55±3	29±5	16±5
10-18	5±1	58±21	17±1	10±2
11-1 (NaCl added)	3±1	96±19	14±5	8±2
12-3	4±10	61±18	41±12	15±3
3-27	8±4	30±7	20±6	16±6
8-1	9±1	18±2	14±1	11±0

[1/] All values are means followed by ± one standard deviation.

Low Plant Population Studies with Maryland Tobacco

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Purpose and Objectives

Tobacco production requires about 230 man-hours of labor per acre. This is because the individual plants are handled many times: pulling from seedbed, transplanting, topping, harvesting, and stripping. Earlier studies with population rates ranging from 6223 to 9680 plants per acre showed that total yield per acre, although often greater at the higher plant population levels, was not proportional to the number of plants per acre. Thus, as plant populations were increased, yield per plant was reduced. The purpose of this test was to study lower than normal plant populations with the idea of determining maximum or optimum levels of production per plant. This would help growers get maximum production per hour of labor.

Procedure

The field test was located on a Monmouth fine sandy loam soil. Four plant population levels, 6223, 4978, 4149, and 3556 plants per acre at 3 nitrogen rates, 50, 70, and 90 pounds per acre were studied. The test was a split-plot design with nitrogen rates as main plots and plant populations as the split plots. Four replications were made and Maryland 872 variety was used. The test was irrigated as needed to maintain optimum growing conditions. At harvest, the sticks of green tobacco were weighed to determine green weight per plant. After curing, the plots were stripped, weighed, graded and priced. Yield per acre and dollar value, yield per plant and % yield of cured leaf to green weight were computed.

Although not an integral part of the test, 18 non-competitive plants were grown to try to determine the maximum potential production of a plant. These plants were spaced 7 feet on centers.

Results and Discussion

The results for the 1975 season of the low plant population studies with Maryland tobacco are in Table 1. The 1975 growing season was not very good for tobacco. Excessive rainfall in mid-July was followed by a dry period lasting until almost mid-August. The overall yield level for the test was about 15% under the 1974 season. The green weight of plants averaged about 25% less than in 1974. However, the % yield of cured leaf to green weight was just over 8% in 1975 and only 7% in 1974.

The lower plant population levels decreased yield per acre and dollar return, but increased green weight per plant and cured leaf per plant. There was little difference in the % yield of cured leaf to green weight over the plant population rates tested. However, none of the plant population rates tested approached the level of green weight per plant, cured leaf per plant, and % cured leaf to green weight obtained from the non-competitive plants.

Response to nitrogen was greatest between the 50 and 70 pound per acre rates. Increasing the nitrogen rate to 90 pounds per acre only increased yield by an average 62 pounds per acre.

In the 1975 season, using the average of all nitrogen rates, if 6223 plants were planted in 42 inch rows with a spacing in the row of:

24 inches, 1 acre is covered for a gross return of $1783

30 inches, 1-1/4 acres are covered for a gross return of $2023

36 inches, 1-1/2 acres are covered for a gross return of $2258

42 inches, 1-3/4 acres are covered for a gross return of $2309.

Summary

The low plant population study with Maryland tobacco was initiated in 1974 and continued in 1975. Although the growing seasons were quite different, the major trends were the same. The lower plant populations decrease yield per acre, but increase yield per plant. Green weight per plant also increases with decreasing plant populations, but average green weights per plant were 25% less in 1975 compared with 1974. It appears from this study thus far that Maryland tobacco farmers would get more return from their labor planting less than 5000 plants per acre than planting over this level.

This study will be continued in 1976.

Table 1. Summary of low plant population study with Maryland tobacco – 1975.

Nitrogen rate (lbs/A)	Plant population per acre	Yield/Acre lbs.	Cents/lb.	$/Acre	Green Wt./Plant lbs.	Cured Leaf Wt./Plant lbs.	% Cured Leaf of Green Wt.
50	6223	1939	87.5	1698	3.87	.31	8.07
	4978	1628	89.2	1457	3.90	.33	8.57
	4149	1618	89.7	1452	4.88	.39	8.10
	3556	1327	90.7	1204	4.67	.37	8.02
Average		1628	89.3	1453	4.33	.35	8.19
70	6223	2003	89.5	1799	4.08	.33	7.88
	4978	1748	90.7	1586	4.23	.35	8.32
	4149	1751	91.7	1606	5.05	.42	8.35
	3556	1525	91.4	1412	5.21	.43	8.26
Average		1757	90.8	1601	4.64	.38	8.20
90	6223	2066	89.7	1854	4.24	.33	7.90
	4978	1917	91.2	1748	4.87	.39	7.94
	4149	1744	90.8	1583	5.23	.42	7.92
	3556	1551	89.3	1384	5.35	.44	8.24
Average		1819	90.2	1642	4.92	.39	8.00
Average over-all nitrogen rates	6223	2002	88.9	1783	4.06	.32	7.95
	4978	1764	90.3	1597	4.33	.36	8.28
	4149	1704	90.7	1547	5.05	.40	8.12
	3556	1468	90.5	1333	5.07	.41	8.17
Non-Competitives					6.00	.58	9.66

Irrigation with Maryland Tobacco, 1975

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Purpose and Objectives

Presently between 15 and 20% of the Maryland tobacco crop can be irrigated if needed. Supplemental water is not necessary every year, but in some seasons the crop value can be doubled. Thus, the objective of this experiment is to gather long term data on the benefit of irrigation to the production of Maryland tobacco and to determine if there is a differential variety response to irrigation.

Procedure

The experiment was a split plot design. Main plots were irrigation and sub plots were varieties — Md. 10, Md. 609, Md. 64, Md. 872, Md. 201, and breeding line J-1F-1. There were four replications for a total of 48 plots.

The test was located at the University of Maryland Tobacco Experimental Farm. The soil was a Monmouth fine sandy loam. The fertilizer application was 90 lbs. N, 120 lbs. P_2O_5 and 180 lbs. K_2O equivalent per acre.

Water was applied to the plots requiring irrigation when the plants started to show moisture stress in the heat of the day. A Skinner overhead pipe system was used for irrigation.

Fifteen plants were harvested and cured from each plot. The cured plants were stripped into farmer grades, weighed, U.S.D.A. grades assigned and priced according to grade. Yield per acre and value was then calculated. A representative sample of the cured leaves from the whole plant was taken for chemical analysis and a leaf from the mid portion of the stalk of each plant was saved for leaf burn and filling capacity tests.

Plants were transplanted into the field on June 4. Two irrigations of about 1¼ inches of water each were applied on August 4 and August 12. The plants were topped on August 7 and harvested on August 20.

Results

The results from the tobacco irrigation study are in Table 1. The response to irrigation was not consistent among the varieties in this year. Md. 10 and BL J-1F-1 both gave a good response to irrigation averaging $190 and $164 more per acre, respectively, with irrigation. Md. 872 and Md. 201 had small decreases in average value per acre with irrigation and Md. 609 and Md. 64 had only small increases in value from irrigation.

These results are not consistent with other years. Both Md. 10 and BL J-1F-1 are of the Catterton type with the early maturity characteristic. Irrigation was not needed until relatively late in the growing season, just before and again just after topping. Irrigation at this stage in past years has always been of greatest benefit to the later maturing varieties.

Chemical analyses, leaf burn and filling capacity are not complete at this time.

Summary

The 1975 growing season was extremely wet in mid-July with over 10 inches of rainfall recorded. This was followed by a dry period in later July through mid August. Two irrigations of 1¼ inches of water were applied during this dry period eight days apart. Response to irrigation was not consistent among varieties. The earlier maturing lines, Md. 10 and BL J-74-1 gave the greatest response averaging $177 more per acre with irrigation. Md. 609 and Md. 64 had only small increases in acre value with irrigation and Md. 872 and Md. 201 had slight decreases in acre value with irrigation.

Table 1. Summary of tobacco irrigation test — 1975.

Variety	Yield/Acre lbs.	Cents/lb.	$/Acre	Response to irrigation - $
		Irrigated		
Maryland 609	1876	92.3	1730	+ 60
Maryland 10	1831	89.4	1638	+ 190
Maryland 64	2044	89.0	1818	+ 74
Maryland 872	1990	91.5	1823	- 12
Maryland 201	1969	89.8	1770	- 39
BL J-1F-1	2023	88.0	1775	+ 164
Average	1955	90.0	1759	+ 72
		Not Irrigated		
Maryland 609	1807	91.8	1670	
Maryland 10	1633	88.6	1448	
Maryland 64	1999	87.3	1744	
Maryland 872	2010	91.2	1835	
Maryland 201	1975	91.6	1809	
BL J-1F-1	1801	89.4	1611	
Average	1873	90.0	1686	

Testing Lodging Resistance of Maryland Tobacco with a Wind Making Machine, 1975

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Purpose and Objectives

Previous work with Maryland tobacco varieties indicated that a wind making machine could be used to test lodging resistance.[1] Lodging resistance will be tested on the most promising advanced breeding lines so that this information will be available prior to release. This season, two advanced breeding lines were evaluated in comparison to four previously tested varieties.

Procedure

Maryland tobacco varieties Md. 872, Md. 201, Md. 609, and Md. 64 were tested along with the advanced breeding lines BL 74-1 and BL 224. The field test was planted on a Monmouth fine sandy loam. Single row plots were used with six replications. When the plants had started to flower, the plots were irrigated with approximately $1\frac{1}{2}$" of water. A John Bean Rotomist 100 mist blower sprayer was used to provide "wind" to blow directly into the single row plots. Estimates of the angle of lean of the first 10 individual plants in each plot were made within 24 hours of treatment. The tobacco plants leaning less than 15 degrees from perpendicular after treatment were not considered to be lodged enough to be of any problem at harvest.

Results

Table 1 shows the percentage of plants of the varieties that were leaning 15 degrees or more after the wind treatment. Md. 64 showed the highest

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[1] McKee, C. G. and M. K. Aycock, Jr. 1976. Field Testing for Lodging Resistance of Maryland Tobacco Cultivars with Artificially Produced Wind. Tob. Sci. 20:1-2.

resistance to lodging and Md. 609 showed the lowest resistance to lodging. This is consistent with results from other years. Md. 872, Md. 201, BL 74-1, and BL 224 were all significantly better for lodging resistance than Md. 609, but not significantly different from Md. 64.

Summary

Breeding lines BL 74-1 and BL 224 in tests this season appear to have ample lodging resistance for release as varieties. These breeding lines will be evaluated again next season if they continue to look promising in other testing.

Table 1. Percentage of tobacco plants leaning 15 degrees or more after blowing with artificially produced wind, 1975.

Variety	% Leaning over 15 degrees
Maryland 64	9
Maryland 201	17
Maryland 872	20
Maryland 609	50
Breeding Line 224	17
Breeding Line 74-1	13
L.S.D. (.05)	19
(.01)	25

The Response of Alfalfa to Irrigation, Fertility and Cutting Management

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Purpose and Objectives

Alfalfa is unquestionably the leading quality hay crop in the Northeast. Alfalfa acreage is presently increasing, partly due to the availability of improved varieties with higher yield potential than the standard cultivars. Although varietal improvement has made significant progress and fertilization practices have changed, other alfalfa management practices have not changed in the last fifteen years.

The overall purpose of this study is to provide new data on alfalfa management by comparing a new cultivar with a standard one. This is being accomplished by looking at the yield and stand persistence under: (1) irrigation and non-irrigation; (2) fertilization at the recommended rate, one-half that rate, and twice that rate; and (3) under four cutting schedules. Forage quality is also being evaluated through chemical analysis.

Procedure

The experimental planting was made in the fall of 1973 on a Chester loam soil. Soil test results showed a pH of 6.8 and MgO, P_2O_5 and K_2O were medium. The cultivars established were Williamsburg and WL311. During the 1974 growing season harvests were taken as previously reported. Following the 1974 growing season, soil test results showed a pH of 6.7 and MgO, P_2O_5, and K_2O were high for the medium fertility plots, medium for the low fertility plots, and very high for the high fertility plots. In early November, 1974, the medium fertility plots received 0-75-150,

the low plots 0-37.5-75, and the high plots 0-150-300. In February Chloro IPC was applied at 2 qts/A to control chickweed. In April 1.75 tons/A of lime and 10 lbs/A of boron were applied to all the plots.

During the 1975 growing season the plots were harvested according to the following management schedules. One fourth of the plots were harvested at early bud followed by a 30 day interval for the rest of the growing season. One fourth of the plots were harvested at full bud followed by a 30 day interval. One fourth of the plots were harvested at full bud followed by a 40 day interval. All the plots were allowed at least 30 days regrowth before a killing frost harvest was taken on October 13,1975. In the plots harvested every 30 days, there were five harvests while in the 40 day plots there were four harvests.

At the beginning of the 1975 growing season, tensiometers were placed in some of the irrigated plots. These tensiometers were placed at depths of 4 inches and 12 inches. During the growing season, irrigation was applied to the irrigated plots when the tensiometers indicated that the plants were approaching a period of moisture stress.

Results

No significant differences between dry matter yields were observed from the irrigated and non-irrigated plots in 1975. An analysis of the data showed that the differences in dry matter yield between cultivars, cutting treatments, fertility levels, cutting treatments X fertility levels, and cutting treatments X cultivars were statistically significant at the 1% level. The means for the significant treatment effects are shown in Tables 1 and 2. Chemical analyses for forage quality have not been completed.

Summary

Yields of weed-free alfalfa for the 1975 growing season for the new cultivar WL311 were significantly higher than for the old cultivar, Williamsburg. The cutting treatments also showed significant differences in yield with the half bloom - 40 day interval and the full bud - 40 day interval treatments outyielding the early bud - 30 day and the full bud - 30 day treatments. In the three levels of fertility, the high rate produced significantly higher yields than the low or medium rates.

Table 1. Interactions of cutting treatments X cultivars expressed in metric tons per hectare of weed-free alfalfa.

Cutting Treatments	Cultivars		
	WL 311 T/ha	Williamsburg T/ha	Average
Half-bloom followed by 40-day interval	9.70 [1/] a	8.70 b	9.20 X
Early bud followed by 30-day interval	6.42 c	4.86 d	5.64 Y
Full bud followed by 30-day interval	6.43 c	5.11 d	5.77 Y
Full bud followed by 40-day interval	9.22 ab	8.70 b	8.96 X
Average	7.94 A	6.84 B	

[1/] Any two means not followed by the same letter are significantly different at the 1% level. Duncan's Multiple Range Test.

Table 2. Interactions of cutting treatments X fertility levels expressed in metric tons per hectare of weed-free alfalfa.

Cutting Treatments	Fertility Levels[1/] Low T/ha	Medium T/ha	High T/ha	Av.
Half-bloom followed by 40-day interval	8.74 ab	9.31 a	9.55 a	9.20 X
Early bud followed by 30-day interval	5.36 cd	4.58 d	6.97 bc	5.64 Y
Full bud followed by 30-day interval	4.55 d	5.20 cd	7.55 ab	5.77 Y
Full bud followed by 40-day interval	8.96 ab	8.97 ab	8.95 ab	8.96 X
Av.	6.90 B	7.02 B	8.26 A	

1/ Low = $\frac{1}{2}$ soil test recommendation, Medium = soil test recommendation, High = double soil test recommendation

2/ Any two means not followed by the same letter are significantly different at the 1% level. Duncan's Multiple Range Test.

Response of Corn to Long-Term No-Tillage and Subsoil Practices

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Purpose and Objectives

The purpose of this continuing study is to evaluate the response of corn to several methods of soil preparation and tillage. The tillage practices include subsoiling at three spacings, plow-planting and no-tillage planting under several conditions, viz., no preparation, disking ahead of the no-tillage planter, and plowing-disking ahead of the no-tillage planter.

Procedures

This study is located at the Wye Institute on the Bertie silt loam (somewhat poorly-drained) and Mattapex silt loam (moderately well-drained) soils. Four replications were used throughout and the plot size was 50 X 20 feet. The corn variety was Pioneer 3369A planted in 30-inch rows on May 6. The no-tillage corn (including a check, disk-plant, and plow-plant treatment) was planted with a modified four-row International Harvester planter. A four-row John Deere planter was used for the conventionally planted corn (including a check, plow-plant, and previously subsoiled treatments).

All plowing and disking was done on the day of planting. The plots to be planted with the no-tillage planter were either left untreated (no-till), disked only, plowed only (plow-plant), or plowed and disked (check). The plots to be planted with the J. D. conventional planter were either plowed and disked (check and previously subsoiled plots), or plowed only (plow-planted).

Fertilizer was broadcast on all plots (including the no-till plots) prior to plowing at the rate of 140-100-100 (lbs. per acre of $N-P_2O_5-K_2O$).

No fertilizer was applied in the row by the planter.

A combination herbicide was applied to all plots on May 6 at the rate of 1.5 pounds AI/A of atrazine (AATREX) and 1.5 pounds AI/A of simazine (PRINCEP). Although no cover crop was planted on the no-tillage plots, a profuse infestation of chickweed covering 50 to 60 percent of the surface was present along with the residue and corn stover from the previous year's crop. These no-tillage plots, in addition to the aforementioned herbicide treatments, received an application of paraquat at the rate of 0.5 pound (one quart) per acre on May 5. The no-tillage corn was planted into the previous year's stover and indigenous weed cover. A heavy infestation of cutworm was noted upon seedling emergence and 2.67 pints per acre of Toxaphene were applied.

Results

The results for the 1975 test on the previously subsoiled plots and the plow-plant treatments are presented in Table 1. The data also include the yields for the period 1967-74.

The yields from the previously subsoiled plots (subsoiling was terminated after 1972) were similar to the check. The 1972 and 1973 yields from all subsoiled plots averaged 17 bu/A and 15 bu/A, respectively, less than the check plots. There was no yield difference noted in the 1975 corn crop. Most of the yield variation between the subsoiled and check plots over the past nine years has not been significant. However, there have been certain years (especially in 1972-73) when the yields from the subsoiled plots have been significantly less, indicating that subsoiling these silt loam soils has produced yield-depressing effects, probably through deterioration of tilth and compaction. While this yield-depressing effect was noted for individual years, there has been no long-term subsoiling influence on yield over the nine-year period.

The plow-plant treatment still appears to be an alternative on these silty soils After eight years of this continuous treatment (Table 1), only slight yield reductions have been noted when compared to the check. This treatment will be continued.

The no-tillage treatment data are presented in Table 2. The 1975 no-tillage yields were the same as the conventionally planted check and the treatment where only disking was used. After seven years of continuous no-tillage corn production, there has been no difference in yield on these plots when compared to conventionally planted corn. For maximum no-tillage production it appears that a fairly dense mulch of the previous year's corn stover and/or a chickweed cover are necessary ground cover conditions at the time of planting. Under these ground cover conditions, therefore, it appears that no-tillage corn production on these soils is feasible without a planted cover crop. It is noteworthy that the chickweed infestation on the no-till plots has been sparse over the last two years when compared to the conventionally managed plots. The most noticeable yield reductions have occurred on those plots where the mulch cover has been sparse. The plant residue on the no-till plots apparently was responsible for the conditions which gave rise to a serious cutworm infestation after the corn seedlings emerged. Little or no cutworm activity was noted on the conventionally treated plots, even though a much more lush chickweed cover was present prior to plowing. Within 24 hours, these worms were controlled with Toxaphene, but reductions in plant populations occurred. The plant population at harvest was 2000 plants per acre less than the conventional plots (19,000 vs. 21,000).

Fall panicum is still the dominant weed in the no-tillage plots

but it does not pose a major problem at this time. The herbicide combination of atrazine and simazine appears to keep it under control until the crop is made.

Summary

After six years (1967-72) of subsoiling these soils, no beneficial effects have been noted as measured by corn yields. In fact there has been a trend toward reduced yields during several of the six years that subsoiling was practiced (1967-72). This yield reduction was most pronounced in 1972 and 1973. Although the plots have not been subsoiled since 1972, the corn yields remained depressed in 1973 (15 bu/A average decrease from the check), indicating the deleterious after-effects of probably compacting these silt loam soils through subsoiling.

No-tillage corn production on these soils without a planted cover crop appears to be feasible as long as a suitable mulch composed of indigenous weeds and previous year's crop residues cover the soil. After seven years of corn production, observations and yield data have indicated that the no-tillage plots have yielded as well as the conventionally planted plots.

Table 1. Average corn yields for the period 1967-75 for four soil management treatments - Wye Institute, Maryland.

	Average Yield (bu/acre)									
Treatment	1967	1968	1969	1970	1971	1972	1973*	1974*	1975*	Mean
Check	112	118	130	122	125	112	106	127	123	119
Subsoiled 22 inches	112	98	113	113	106	98	90	120	126	108
Subsoiled 44 inches	115	116	123	97	115	94	90	126	118	110
Subsoiled 80 inches	115	105	103	101	97	93	88	112	124	104
Plow-planted	-	98	120	117	114	105	98	114	126	112

*The 1973-75 plots were not subsoiled, but were recorded separately to determine any after-effects of the previous six years subsoiling.

Table 2. Average corn yields for no-tillage treatments as compared to conventional planting - Wye Institute, Maryland.

	Average yield (bu/acre)							
Treatment	1969	1970	1971*	1972	1973	1974	1975	Mean
Check; plowed, disked	125	97	88	94	98	119	117	105
Disked only	131	118	65	90	91	114	120	104
No-tillage (stover)	136	102	71	100	86	123	115	105

*A rye cover crop was planted in the fall of 1970. To simulate no-tillage planting with no cover crop, the rye was cut and removed. The corn was then planted into the rye stubble. Where the corn was planted into the rye cover crop, the yield averaged 112 bu/acre. The low yields resulted primarily from poor stands caused by the no-tillage planter being adjusted for planting in a cover crop.

Effects of Simulated Salt Drift on Maryland Tobacco Using Brackish Water from Cooling Towers at Chalk Point

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Purpose and Objectives

In studies[1/] investigating the responses of Maryland tobacco to additions of chloride either to the soil as $CaCl_2$ or from foliar sprays as NaCl, Maryland tobacco was observed to rapidly accumulate chloride from both sources. Also, evidence that small amounts of chloride may be beneficial was observed; however, excessive amounts of chloride may adversely affect the quality of tobacco. The cooling towers at Chalk Point, which began operations in May of 1975, are projected to release sizable quantities of salts into the atmosphere. However, with adequate atmospheric dispersion, only small quantities are projected to be deposited on the crops growing near the towers. It was of interest to examine the response of tobacco to applications of spray mist using brackish water from the operating towers in amounts within the range of the quantities projected for the area near the towers. The information will be useful in interpretation of tobacco being collected from research sites near the Chalk Point cooling towers.

Procedures

A study was conducted at the Tobacco Experimental Farm near Upper Marlboro, Md. during the summer of 1975 on a Monmouth fine sandy loam soil. The study was fertilized according to soil test recommendations and utilized variety Md. 609. The tobacco was planted, cultured, harvested, cured and stripped consistant with established practices for Maryland air-cured tobacco.

1/ C. L. Mulchi and W. W. Newcomb. 1975. Crops and Soils Research. Md. Agri. Exp. Sta. 8: 194-199; 8: 200-205.

A randomized complete block design with four replications was employed. A plot consisted of four rows spaced one meter apart and 7.6 meters in length. The plants were spaced 0.6 meters apart in the rows. The two center rows received the treatments and the two outside rows served as border rows to reduce drift contamination from adjacent plots. Four treatments with brackish water were employed: control, 17.1, 34.2 and 51.3 l/ha/day. The treatments were applied with a motorized sprayer equipped with three sets of four nozzles each spaced 0.5 meters apart. The four nozzles (Conejet TXISS, Agrotec Inc., Salisbury, Md.) were spaced to apply the simulated drift uniformly over the two center rows in the plots. The sprayer was equipped with a combination valve which allowed the application of 1X, 2X or 3X with X being the amount of spray from a single set of four nozzles. The pressure relief valve was set at 4.22 kg/cm^2 (60 psi) and each nozzle was checked and found to deliver 1.3 ml/sec. From previous work, the mean droplet size for the spray mist was observed to be about 100 microns in size. A ground speed of about 1.5 m/sec was maintained for the daily treatments. With the combination valve and the three sets of nozzles, all treatments could be accomplished in a single pass. It should be noted that the machine was driven through the control plots even though no spray mist was being applied. For all treatments, the nozzles were adjusted to about 0.5 meters above the plant canopy.

In mid-June, after the plants had become established following transplanting, a large container (50 gallons) of water was obtained from the operating cooling tower at Chalk Point. The sediments in the brackish water were allowed to settle out for several days then sediment-free water was siphoned from the top of the container directly into the large capacity (150 gallon) tank on the sprayer. The electrical conductivity (E.C.) of

the water was found to be 13.5 mmhos/cm or about 8,650 ppm total salts. The low salinity was caused by the large quantities of fresh water entering the Patuxent River from heavy rains. The low saline water from the tower was used for the first three weeks of spray treatments before a second batch of water was collected from the tower. The second batch had an E.C. of 21.9 mmhos/cm or a total salt content of about 14,000 ppm. The second batch was used for the duration of the spray treatments. Samples of both batches of cooling tower water were analyzed in the Soil Testing Laboratory for mineral contents.

Vegetative samples were collected after three weeks of treatments when the tobacco plants were about 0.5 meters in height. These samples were rinsed with distilled water, oven dried at 70 C, ground, then analyzed for P, K, Ca, Mg, Na and Cl contents.

In late August, a few days following the last spray application, the plots were harvested by cutting ten uniform plants from each of the two center rows. The plants were speared onto sticks and placed in barns for curing. After curing, data was collected on plot yields (lbs/A), average price ($/100 lbs), value ($/A), and quality index (1-100). Composite samples were obtained from the cured tobacco and analyzed for P, K, Ca, Na, Cl, total alkaloids and total nitrogen contents. A 25 leaf sample was randomly selected from the "bright" grade (center stalk position) and subjected to burn and filling capacity tests.

Results

The mineral composition of the two batches of cooling tower water utilized in the simulated drift study are shown in Table 1. Batch No. 2 had a much higher salinity than No. 1 with the elements sodium and chloride being by far the most abundant salts. It is of interest that the relative rankings

for the elements with respect to their relative abundances appeared about the same in both batches of water with $Cl > Na > Ca > Mg > K > NO_3$. The amounts of the essential elements K, Ca and Mg present in both batches were surprisingly high and may offer some nutritional benefit to plants when foliar applied.

The results from the chemical analysis for mineral contents in the young tobacco receiving foliar sprays are shown in Table 2. The plots receiving the spray treatments showed significantly higher K, Ca, Mg, Na and Cl contents which resulted in significantly lower metabolic index values for the treated plots. This was most apparent at the 17.1 and 34.2 l/ha/day treatments. These results suggest that the brackish water may have been beneficial through supplying supplemental K, Ca and Mg to the growing plants.

A summary of the agronomic, chemical and physical properties of tobacco from the various treatments are shown in Table 3. Note that there were significant increases in yields, total chlorides and filling capacity in the tobacco receiving spray treatments. Also, there was an apparent trend for increased value, especially at the lower treatments. A somewhat surprising observation was the slight improvement in burning qualities rather than a lowering of burn.

The effects of cooling tower water treatments on the mineral composition of the cured tobacco are summarized on Table 4. There were significant increases in both sodium and chloride contents and a significant decrease in the metabolic index or nutrient balance in the tissue. It is of interest that the levels of chloride attained in the tissue (0.501%) were within the range of chloride contents observed in samples of Maryland tobacco collected from farms over the 1973, 1974 and 1975 period.

These results would suggest that the foliar spray applications of

cooling tower water may have caused more beneficial than harmful effects on the tobacco. This perhaps can be explained by considering several factors. First, the level of chlorides attained by the tobacco reached only 0.501% or remained within the typical range (0.31 $\pm$ 0.20%) for chlorides in Maryland tobacco. Results from earlier studies had shown positive responses regarding yields by small additions of chloride from either fertilizer or foliar sources. Second, there may have been beneficial effects regarding burn from the foliar applied potassium. The improvement in filling capacity may also have been caused by the added nutrients in the brackish water. However, one should view these results with precautions since the simulated salt drift study was conducted for only eight weeks. In reality, the towers at Chalk Point may operate continuously for months thus allowing some buildup of salts in the soil which, when combined with the foliar salts during the growing season, may be sufficient to induce certain non-desirable effects such as reduced burn or quality.

It is important that the levels of salts released by the towers not cause such adverse effects as leaf burn. No visual symptoms of adverse effects were observed during the eight weeks. The tobacco appeared quite normal and healthy. Although the quality index (Table 3) for the cured tobacco suggested a slight reduction in desirable features may have been present in the cured tobacco from plots which received the spray treatments, the increases in yields overshadowed these adverse effects.

Summary

Tobacco grown at the Tobacco Experimental Farm and exposed to treatments utilizing brackish water from operating cooling towers at Chalk Point to simulate salt drift from the towers on crops showed more beneficial than harmful effects from the spray treatments. Compared to nontreated controls,

the plots receiving applications of salt spray exhibited higher yields, improved value, increased filling capacity and no significant effects on alkaloids, total nitrogen, leaf burn, average price or leaf quality. There were significant increases in sodium and chloride in the plant tissue.

The beneficial effects may be attributable to (1) the overall modest increases in chlorides in the plant tissue, (2) some nutritional benefits from the other essential plant nutrients present in the brackish water and (3) the absence of appreciable soil chlorides which would likely be present in areas near the operating cooling towers using brackish water.

Acknowledgement

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Table 1. Mineral composition of water from the Chalk Point cooling towers used in the spray studies. 1975.

Collection Date	Batch No.	Chemical Composition						Electrical Conductivity[1/] mmhos/cm
		K ppm	Ca ppm	Mg ppm	NO_3 ppm	Na ppm	Cl ppm	
6-13-75	1	86	147	125	0.10	2140	4497	13.5
7-11-75	2	165	244	230	1.01	4320	8734	21.9

[1/] For converting E.C. values to ppm total salinity, multiply by 640.

Table 2. Effects of simulated salt drift using water from the Chalk Point cooling tower on the mineral contents of green tissue samples from young tobacco. 1975.

Treatment Volume l/ha/day	Mineral Content						Metabolic Index[1/]
	P %	K %	Ca %	Mg %	Na %	Cl %	
0	0.21	3.13	1.47	0.47	0.092	0.10	27.6
17.1	0.19	3.45	1.63	0.49	0.120	0.17	19.7
34.2	0.20	3.75	1.85	0.66	0.168	0.30	13.9
51.3	0.19	2.98	1.45	0.46	0.177	0.36	9.5
Mean	0.20	3.33	1.60	0.52	0.139	0.23	17.7
LSD(0.05)	NS	0.55	0.26	0.080	0.025	0.037	2.1
CV (%)	10.3	10.4	10.4	9.7	11.5	10.2	7.4

[1/] Calculated by: $P + K + Ca + Mg / Na + Cl$

Table 3. Effects of simulated salt drift[1/] using water from the Chalk Point cooling towers on the agronomic chemical and physical properties of Maryland tobacco. 1975.

Treatment		Agronomic				Chemical			Physical	
Spray[2/] Volume	Total[3/] Salts Applied	Yields	Av. Price	Value	Quality	Total Alkaloids	Total Nitrogen	Total Chlorides	Burn	Filling Capacity
l/ha/day	kg/ha	lbs/A	$/100 lbs	$/A	(0-100)	%	%	%	Sec.	cm^3/gm
0	0	1836	89.26	1641	75.25	2.98	3.33	0.292	14.9	7.2
17.1	8.21	2015	89.32	1801	74.78	3.01	3.17	0.393	15.6	7.4
34.2	16.42	2017	88.51	1784	73.21	3.16	3.29	0.403	15.5	8.4
51.3	24.62	1901	89.27	1697	74.37	2.87	3.21	0.501	15.7	7.7
Mean $\bar{x}$		1943	89.98	1731	74.40	3.00	3.25	0.397	15.4	7.7
LSD (0.05)		148	NS	NS	NS	NS	NS	0.079	NS	0.633
CV (%)		4.8	1.5	5.5	7.6	5.7	7.3	12.6	34.6	5.15

1/ Applied as spray mist with 100 micron droplets five days perweek for eight weeks.

2/ To convert to gal/A/day, multiply by 0.105. Water with an E.C. of 13.5 mmhos/cm was used for the first three weeks and 21.9 mmhos/cm for the remaining five weeks. The amounts of salts applied for the 17.1 l/ha/day treatment equaled approximately 147 and 240 g/ha/day, respectively for the two spray periods, assuming an E.C. of 1 mmhos/cm equaled 640 ppm salts.

3/ Estimate of total salts applied during the eight weeks. To convert to lbs/A, divide by 1.1.

Table 4. Effects of simulated salt drift[1/] using water from the Chalk Point cooling towers on the mineral contents of composit samples of cured tobacco. 1975.

Spray Volume l/ha/day	Total Salts Applied kg/ha	Mineral Contents P %	K %	Ca %	Mg %	Na %	Cl %	Metabolic[2/] Index
0	0	0.21	4.0	1.63	1.22	0.129	0.294	16.8
17.1	8.21	0.21	4.2	1.62	1.26	0.132	0.393	13.9
34.2	16.42	0.21	3.9	1.54	1.16	0.163	0.402	12.0
51.3	24.62	0.21	4.1	1.62	1.24	0.184	0.501	10.6
mean		0.21	4.1	1.60	1.22	0.152	0.398	13.3
LSD(0.05)		NS	NS	NS	NS	0.027	0.081	1.7
CV (%)		5.8	4.1	4.7	13.8	11.0	12.8	8.0

1/ Applied as spray mist with 100 micron droplets five days per week for eight weeks.
2/ Calculated by P + K + Ca + Mg /Na + Cl

Effects of Simulated Salt Drift on Corn and Soybeans Using Brackish Water from the Cooling Towers at Chalk Point

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Purpose and Objectives

In conjunction with an on-going research and monitoring program examining the effects of salt drift from the cooling towers at Chalk Point on crops and soils, it was of interest to expose corn and soybeans to various levels of salt drift using brackish water from the operating towers. Of particular interest were the effects of salt drift on yields and nutrient contents in the leaves of the plants. From previous studies involving the foliar application of NaCl to corn and soybeans[1/], corn plants were observed as being moderately tolerant to salt spray early in the growth cycle but became more sensitive with plant maturity compared to soybeans. However, corn yields appeared more subject to being reduced than soybean yields from salt spray applications.

Procedures

The procedures described in the preceeding report for investigating the effects of simulated salt drift on Maryland tobacco were identical to those used in the current studies. The plot sizes, statistical designs and treatments were the same as those previously described. The reader is referred to the proceeding report for details on procedures used in the current studies.

The varieties of corn and soybeans planted were Pioneer 3369A and York, respectively. Both studies were fertilized according to soil test recommendations and the experiments were planted in early June. Spary treatments were initiated as soon as plant stands were assured.

[1/] C. L. Mulchi and J. A. Armbruster. 1975. Crops and Soils Research. Md. Agri. Exp. Station. 8: 206-212; 8: 213-218.

Vegetative samples were collected from the individual plots for both crops three weeks after the spray treatments were initiated. A second set of vegetative samples were collected from the corn plots about the time the spray treatments were terminated in late August. The samples were rinsed with distilled water, oven dried at 70C, ground, then analyzed for P, K, Ca, Mg, Na and Cl.

The spray treatments were terminated after eight weeks and the plants were allowed to complete their growth cycles. Spraying the beans beyond eight weeks would risk substantial mechanical damage to the plant canopy. The corn had completed pollination and was rapidly approaching maturity when the treatments were terminated. The plots were harvested in early October and yield estimates were determined from 6 meter lengths from the two center rows.

Results

The results in Tables 1 & 2 summarize the influence of cooling tower water spray treatments on the nutrient contents in the young soybean and corn plants, respectively. These results support a previously reported observation that young soybean plants appear to assimilate salt ions more readily than young corn plants. As shown in Table 1, there were significant increases in Na and Cl and a significant change in the metabolic index or nutrient balance by about 50%. However, there were no significant changes in Na and Cl contents and metabolic index in the first set of vegetative samples from the corn plots, Table 2.

Another interesting observation regarding the nutrient data for the two crops was that there appeared to be no beneficial effects from the K, Ca and Mg in the cooling tower water. This would suggest that young corn and soybean plants differ in this regards compared to young tobacco plants. In fact, there were trends for lower K and Ca in the soybean tissue ex-

posed to the salt mist treatments.

As shown in Table 3, significant increases in the Na and Cl contents in the corn leaves did occur by the end of the eight weeks of spray treatments. Also, the reduction in the metabolic index values for the second set of vegetative samples for corn would suggest a significant change in the nutrient balance in the corn leaves likewise had occurred. Also, there were trends for increases in K, Ca and Mg contents in the corn tissue, especially at the 17.1 and 34.2 l/ha/day treatments, Table 3.

The effects of the spray treatments on yields of corn and soybeans are shown in Table 4. For soybeans, there was no evidence of significant reductions in yields resulting from the spray treatments. However, for corn, a trend for reduced yields with increased spray applications was present although nonsignificant at the 95% level of probability. Similar reductions in corn yields have been observed in previous salt spray studies thus provides support for suggesting that salt drift may affect corn yields more readily than those for soybeans.

Summary

Corn and soybean plants were exposed to salt spray treatments utilizing brackish water from the cooling towers at Chalk Point. The young soybean plants appeared to be more responsive regarding the foliar absorption of salt ions than the young corn plants. However, by the end of the eight-week spray study, significant increases of Na and Cl were observed in the corn vegetation.

The corn and soybean plants appeared not to benefit from the K, Ca and Mg present in the brackish water. However, significant alterations in the balance of nutrients in the tissue from both corn and soybeans were observed with increased levels of application of cooling tower water.

The effects of cooling tower water spray on yields were nonsignificant for both crops at the 95% probability level; however, corn yields tended to be reduced with increased spray treatments.

Acknowledgement

Financial support for the research was provided by the Maryland Department of Natural Resources - Power Plant Siting Program and administered through the Water Resources Research Center. The authors wish to thank Dr. Richard Nietubicz, Project Engineer for the Chalk Point Cooling Tower Project, and Dr. R. L. Green, Coordinator of the Water Resources Research Center, for their assistance with the project.

Table 1. Effects of simulated salt drift using water from the Chalk Point cooling towers on the nutrient contents and metabolic index values for young soybean plants. 1975.

Treatments Spray Volume[2] l/ha/day	Nutrient Contents						Metabolic Index[1]
	P	K	Ca	Mg	Na	Cl	
	%	%	%	%	%	%	
0	0.22	2.55	1.13	0.82	0.094	0.08	27.5
17.1	0.22	2.45	1.18	0.86	0.100	0.12	21.9
34.2	0.21	2.30	1.08	0.85	0.108	0.18	15.3
51.3	0.20	2.23	1.03	0.72	0.107	0.22	13.1
mean	0.21	2.38	1.10	0.81	0.102	0.15	19.5
LSD(0.05)	NS	NS	NS	NS	0.009	0.02	1.9
CV(%)	9.1	7.9	8.5	14.1	5.7	9.6	6.0

[1] Calculated by P + K + Ca + Mg / Na + Cl.

Table 2. Effects of simulated salt drift using water from the Chalk Point cooling towers on the nutrient contents and metabolic index values for young corn plants. 1975.

Treatments Spray Volume[2/] l/ha/day	Nutrient Contents						Metabolic Index[1/]
	P %	K %	Ca %	Mg %	Na %	Cl %	
	0.27	2.75	0.35	0.35	0.098	0.26	10.8
17.1	0.31	2.93	0.30	0.32	0.099	0.31	9.7
34.2	0.28	2.85	0.32	0.29	0.105	0.29	9.5
51.3	0.29	2.85	0.33	0.32	0.128	0.32	8.6
mean	0.29	2.84	0.32	0.32	0.105	0.29	9.7
LSD(0.05)	NS	NS	NS	0.04	NS	NS	NS
CV(%)	11.5	7.2	21.2	7.4	20.9	10.2	10.9

[1/] Calculated by: P + K + Ca + Mg / Na + Cl

[2/] The treatments were applied five days per week for eight weeks. The first three weeks utilized water with an E.C. of 13.5 mmhos/cm. The remaining five weeks utilized water with an E.C. of 21.9 mmhos/cm.

Table 3. Effects of simulated salt drift using water from the Chalk Point cooling towers on the nutrient contents and metabolic index values for corn at tasseling.

Treatments Spray[1/] Volume l/ha/day	Nutrient Contents P %	K %	Ca %	Mg %	Na %	Cl %	Metabolic[1/] Index
	0.20	2.05	0.33	0.32	0.11	0.18	9.8
17.1	0.20	2.10	0.36	0.34	0.14	0.23	8.2
34.2	0.20	2.22	0.36	0.37	0.18	0.24	7.5
51.3	0.20	2.00	0.37	0.35	0.24	0.32	5.3
mean	0.20	2.09	0.35	0.34	0.17	0.24	7.7
LSD(0.05)	NS	NS	NS	NS	0.06	0.03	1.6
CV(%)	6.4	12.0	7.1	7.1	23.6	8.7	12.9

[1/] Calculated by: $P + K + Ca + Mg / Na + Cl$

[2/] The treatments were applied five days per week for eight weeks. The first three weeks utilized water with an E.C. of 13.5 mmhos/cm. The remaining five weeks utilized water with an E.C. of 21.9 mmhos/cm.

Table 4. Corn and soybean yields following eight weeks of spray treatments with brackish water from the Chalk Point Cooling Tower. 1975.

Treatments					
Spray Volume[1/] l/ha/day	Total Salts[2/] kg/ha	Corn		Soybeans	
		Bu/A	kg/ha	Bu/A	kg/ha
0	0	106.6	6680	43.6	2930
17.1	8.21	107.8	7650	44.5	2990
34.2	16.42	102.5	6430	43.4	2910
51.3	24.62	93.6	5880	42.8	2880
mean		102.6	6440	43.6	2930
LSD(0.05)		NS	NS	NS	NS
CV(%)		11.8	11.8	6.4	6.4

1/ To convert to gal/A/day, multiply by 0.105. Treatments were applied 5 days per week for eight weeks. Water with an E.C. of 13.5 mmhos/cm was used for the first 3 weeks and 21.9 mmhos/cm for the remaining five weeks. The amounts of salts applied for the 17.1 l/ha/day treatment equaled approximately 147 and 240 g/ha/day, respectively, for the two solutions, assuming an E.C. of 1 mmhos/cm equaled 640 ppm salts.

2/ Estimate of total salts applied over the eight week period. To convert to lbs/A, divide by 1.1.

Influence of Nitrogen Sources on the Response of Maryland Tobacco to Chloride Fertilization

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Purpose and Objectives

Field studies with Maryland tobacco have shown that additions of chloride to the soil or applied by foliar spray can alter the agronomic, chemical and physical properties of cured tobacco. Research with other types of tobacco have revealed that nitrate sources of nitrogen reduced the impact of the chloride on tobacco, especially with regard to burning quality. A sizable acreage of tobacco is grown in an area surrounding the cooling towers at Chalk Point which are currently being investigated for their potential for salt damage to crops. Information is needed to formulate recommendations for growing tobacco in the region exposed to salt drift from the towers.

Procedures

During the summer of 1975, a study was conducted at the Tobacco Experimental Farm near Upper Marlboro, Md. in which tobacco was planted in plots fertilized with five rates of chloride and three sources of nitrogen in a split-plot design with three applications. The whole plot treatments were the application of 0, 22, 44, 66 and 88 kg/ha of chloride from $CaCl_2$. The $CaCl_2$ was applied uniformly over the soil with spray equipment. The subplot treatments were three sources of nitrogen - ammonium sulfate, amamonium nitrate and calcium nitrate. The rate of nitrogen application for all plots was 132 kg/ha - ie. 66 kg/ha of N at preplant, 33 kg/ha of N as sidedressing and 33 kg/ha of N as a second sidedressing following leaching rains in early July. An individual plot consisted of two rows 1 m apart and 7.6 m long with plants spaced 0.6 m apart in the rows. Border rows were used to separate the whole plots but not the subplots. All plots were

fertilized with other nutrients at rates recommended by the Soil Testing Laboratory.

Variety Md. 609 was utilized for the study. The plants were planted, cultured, harvested, cured, and stripped consistent with recommended procedures for Maryland air-cured tobacco. At harvest, 10 uniform plants were cut from each plot row, speared onto sticks then hung in the barns for air curing. During stripping, information was collected on yields(lbs/A), average price($/100 lbs), value($/A), and quality(0-100). From composite samples obtained from the various grades for each plot on a proportionate weight basis, data on total alkaloids, total nitrogen, and the P, K, Ca, Mg, Na and Cl contents in the cured tissue were determined in the laboratory. Burn (sec) and filling capacity (cm^3/g) test were conducted on 25-leaf samples pulled from the "bright" grade from each plot.

Results

The results in Tables 1 & 2 summarize the agronomic, chemical and physical characteristics of the cured tobacco from the chloride-nitrogen study. There were trends for higher yields and value with additions of chloride with the calcium nitrate nitrogen source giving the best overall results. However, neither of the responses were statistically significant. The lack of significance from the chloride additions can be attributed to the large variability in the data which may have been caused by the leaching rains. With respect to average price and quality, there were trends for reductions at the highest chloride application but no significant differences caused by nitrogen sources. The plots receiving all of their nitrogen from ammonia perhaps exhibited some undesirable quality features. These can be associated with the greater uptake of ammonia than nitrate. The alkaloid levels appeared unaffected by either chloride or nitrogen

sources.

The most significant effects of chloride applications were on the levels of chloride in the tissue, the metabolic index or balance of nutrients in the tissue and the burning qualities of the tobacco. Increases in chloride applications significantly increased the chloride levels in the tissue, and significantly reduced both the metabolic index and burning qualities of the tobacco. The correlation coefficients for chloride levels in the tissue vs. burn was r=0.64. A linear regression analysis of tissue chlorides vs. burn is summarized in Equation (1).

$$Y = 10.4 - 4.12\ X \qquad (1)$$

where Y = burn (sec.)
X = percent Cl in tissue (%)
Std. error = 3.10 sec.

A one percent rise in tissue chlorides on a dry weight basis, would result in a reduction in burn per leaf by about 4.12 second or approximately 40 percent of control.

Similarly, the correlation coefficient for a comparison of metabolic index values vs. burn was r=0.61. A linear regression analysis of metabolic index values vs. burn is summarized in Equation (2).

$$Y = 3.80 + 0.296\ X \qquad (2)$$

Y = burn (sec.)
X = metabolic index units
Std. error = 3.12 sec.

Therefore, the higher the metabolic index values, the better the burning qualities of the tobacco.

The source of nitrogen caused several significant changes in the mineral composition of the cured tobacco. Calcium nitrate induced lower phosphorus and potassium levels and higher calcium levels than the other nitrogen sources. Also, the tissue chloride levels in the calcium nitrate plots

tended to be lower than for the other plots, especially at the higher chloride levels (Table 2).

The burning qualities of the tobacco was only slightly affected by the nitrogen sources. The highest burn levels were observed in the zero chloride plots receiving at least a portion of their nitrogen from nitrate. Although nonsignificant, there was a trend for reduced burn with additions of ammonia across all chloride treatments except the 88 kg/ha treatments (Table 1).

Summary

Tobacco plants were exposed to increasing levels of chloride in the fertilizer (calcium chloride) and to three sources of nitrogen (ammonium sulfate, ammonium nitrate and calcium nitrate) to determine if the source of nitrogen could counteract the negative effects of chloride. Information on agronomic, chemical and physical properties were examined. Trends for increased yields and value were found with increased chloride and for nitrate nitrogen. Leaf burn was negatively correlated with chloride levels in the tissue and positively correlated with the metabolic index or nutrient balance. Calcium nitrate significantly reduced the phosphorous and potassium levels and increased the calcium levels in the tissue.

Table 1. Summary of effects of soil chloride vs. nitrogen sources on the agronomic, chemical and physical properties of Maryland tobacco. 1975.

Soil Chloride (kg/ha)	Nitrogen Source: Ammonium Sulfate	Ammonium Nitrate	Calcium Nitrate	Mean (C)
	YIELD (lbs/A)			
0	1623	1637	1638	1632
22	1671	1713	1761	1715
44	1786	1710	1829	1775
66	1656	1668	1774	1699
88	1687	1710	1953	1783
mean (N)	1685	1688	1781	1721[1/]
	LSD(0.05)[2/] (C) 430	CV(%) (C) 23.0		
	(N) 156	(N) 11.9		
	(N/C) 349			
	VALUE ($/A)			
0	1435	1472	1455	1454
22	1467	1523	1541	1510
44	1565	1478	1633	1559
66	1438	1469	1568	1492
88	1462	1489	1686	1546
mean (N)	1473	1486	1576	1512[1/]
	LSD(0.05)[2/] (C) 403	CV(%) (C) 24.6		
	(N) 131	(N) 11.4		
	(N/C) 292			
	TOTAL AKALOIDS (%)			
0	2.63	2.79	2.65	2.69
22	2.82	2.82	2.76	2.80
44	2.76	2.56	2.65	2.66
66	2.71	2.48	2.64	2.61
88	2.91	2.61	3.07	2.86
mean (N)	2.77	2.65	2.76	2.73[1/]
	LSD(0.05) (C) 0.21	CV(%) (C) 7.0		
	(N) 0.12	(N) 5.9		
	(N/C) 0.27			
	BURN (Sec)			
0	9.08	13.71	12.03	11.61
22	6.52	7.92	9.26	7.90
44	7.64	7.07	9.23	7.98
66	4.16	4.74	4.91	4.60
88	4.71	2.93	2.79	3.47
mean (N)	6.42	7.27	7.64	7.11[1/]
	LSD(0.05) (C) 4.68*	CV(%) (C) 60.6		
	(N) 1.54	(N) 28.6		
	(N/C) 3.46			

Soil Chloride (kg/ha)	Nitrogen Source: Ammonium Sulfate	Ammonium Nitrate	Calcium Nitrate	Mean (C)
	AV. PRICE ($/100 lbs.)			
0	88.43	89.80	88.71	88.98
22	87.84	88.88	87.52	88.08
44	87.65	86.19	89.23	87.69
66	86.73	87.94	88.42	87.70
88	86.67	87.04	86.45	86.72
mean (N)	87.46	87.97	88.07	87.83[1/]
	LSD(0.05) (C) 1.75	CV(%) (C) 1.8		
	(N) 1.19	(N) 1.8		
	(N/C) 2.66			
	QUALITY INDEX (0-100)			
0	70.60	76.32	71.37	72.76
22	67.68	70.23	67.86	68.59
44	67.76	70.43	72.06	70.08
66	65.87	69.00	71.28	68.72
88	64.71	65.35	65.89	65.33
mean (N)	67.33	70.27	69.69	69.09[1/]
	LSD(0.05) (C) 5.69	CV(%) (C) 7.6		
	(N) 3.32	(N) 6.9		
	(N/C) 8.11			
	TOTAL NITROGEN (%)			
0	3.27	3.07	3.12	3.04
22	3.33	3.11	2.99	3.15
44	2.82	3.12	3.02	2.98
66	2.99	2.85	3.02	2.96
88	3.15	2.97	3.01	3.04
mean (N)	3.12	3.02	2.96	3.04[1/]
	LSD(0.05) (C) 0.43	CV(%) (C) 13.1		
	(N) 0.20	(N) 8.8		
	(N/C) 0.45			
	FILLING CAPACITY (cm^3/g)			
0	6.46	6.46	6.46	6.46
22	7.40	6.60	5.66	6.55
44	6.93	6.73	6.66	6.77
66	6.60	6.30	6.60	6.51
88	6.86	6.66	6.13	6.55
mean (N)	6.85	6.56	6.31	6.57[1/]
	LSD(0.05) (C) 1.25	CV(%) (C) 17.6		
	(N) 0.62	(N) 12.4		
	(N/C) 1.38			

[1/] Grand mean.

[2/] Comparisons having * on the appropriate LSD value are significantly different at the 95% level of probability.

Table 2. Summary of effects of soil chloride vs. nitrogen sources on the nutrient contents in composite samples of cured Maryland tobacco. 1975.

Soil Chloride (kg/ha)	Nitrogen Sources: Ammonium Sulfate	Ammonium Nitrate	Calcium Nitrate	Mean (C)	Nitrogen Sources: Ammonium Sulfate	Ammonium Nitrate	Calcium Nitrate	Mean (C)
	PHOSPHORUS (%)				POTASSIUM			
0	0.21	0.22	0.22	0.21	4.0	3.9	3.9	3.9
22	0.23	0.21	0.20	0.21	4.2	3.9	3.8	3.9
44	0.23	0.23	0.19	0.21	4.0	4.2	3.8	4.0
66	0.23	0.22	0.21	0.22	4.2	4.1	3.9	4.1
88	0.23	0.20	0.20	0.21	4.1	3.7	3.7	3.8
mean (N)	0.22	0.21	0.20	0.21[1]	4.1	4.0	3.8	4.0[1]
LSD(0.05)[2]	(C)0.02	CV(%)	(C)10.8		LSD(0.05)	(C)0.3	CV(%)	(C) 6.8
	(N)0.01*		(N) 8.0			(N)0.2*		(N) 5.7
	(N/C)0.03					(N/C)0.4		
	CALCIUM (%)				MAGNESIUM (%)			
0	1.29	1.29	1.46	1.35	1.07	0.98	1.21	1.09
22	1.37	1.45	1.56	1.46	1.07	1.05	1.00	1.04
44	1.43	1.47	1.69	1.53	1.07	1.17	1.06	1.10
66	1.43	1.44	1.61	1.49	1.13	1.22	1.16	1.17
88	1.54	1.49	1.72	1.58	1.15	1.05	0.96	1.05
mean (N)	1.41	1.42	1.61	1.48[1]	1.09	1.09	1.08	1.09[1]
LSD(0.05)	(C)0.28	CV(%)	(C)17.6		LSD(0.05)	(C)0.19	CV(%)	(C)15.9
	(N)0.07*		(N) 6.2			(N)0.09		(N)11.0
	(N/C)0.16					(N/C)0.20		
	SODIUM (%)				CHLORIDE (%)			
0	0.105	0.111	0.103	0.106	0.190	0.131	0.250	0.190
22	0.103	0.103	0.111	0.105	0.542	0.582	0.262	0.462
44	0.117	0.127	0.111	0.119	0.660	1.306	0.717	0.894
66	0.111	0.115	0.108	0.112	1.392	1.277	1.134	1.267
88	0.111	0.118	0.112	0.114	1.659	1.516	1.244	1.473
mean (N)	0.109	0.115	0.109	0.111[1]	0.889	0.962	0.721	0.857[1]
LSD(0.05)	(C)0.009	CV(%)	(C) 7.7		LSD(0.05)	(C)0.316*	CV(%)	(C)33.9
	(N)0.005		(N) 6.7			(N)0.274		(N)42.0
	(N/C)0.012					(N/C)0.614		
	METABOLIC INDEX[3] (0-100)							
0	24.4	26.7	20.3	23.8				
22	11.5	12.6	18.4	14.2				
44	9.6	4.9	8.8	7.8				
66	5.4	5.2	6.2	5.6				
88	4.1	4.5	5.0	4.5				
mean (N)	11.0	10.8	11.7	11.8[1]				
LSD(0.05)	(C)[2] 5.8 *	CV(%)	(C)45.0					
	(N)2.3		(N)25.3					
	(N/C)5.1 *							

[1] Grand mean.

[2] Comparisons having * on the appropriate LSD values are significantly different at the 95% level of probability.

[3] Calculated by: P + K + Ca + Mg / Na + Cl.

The Use of Organic Preservatives on Aerobically Stored High Moisture Forage

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Purpose and Objectives

In terms of acreage, hay is the third largest crop in Maryland, but haymaking is one of the most risky agricultural activities. A substantial amount of the hay is ruined before it is ready for baling. Long term weather records show there is a 95 percent probability that only three periods will occur in May with three or more consecutive rain-free days suitable for drying hay. If the normal three-day drying period could be reduced to two days, four drying periods could be expected in May according to these data. This is a 33 percent increase in the probability of effective drying periods.

Research has indicated that organic preservatives such as ammonium isobutyrate and propionic acid are effective in preserving high moisture hay. A commercially available hay preservative sold under the name of "Haylosyn" contains small amounts of propionic acid and has been advertized to be effective in preserving hay at high moisture levels.

The objective of experiment I was to compare the preserving ability of propionic acid, ammonium isobutyrate, and Haylosyn when applied to hay baled at several moisture levels. In a second experiment, the effectiveness of ammonium isobutyrate (AIB) field applied on large batches of hay was evaluated.

Procedure

In experiment I, long-loose alfalfa-timothy second cut hay was brought from the field at average moisture levels of 20 and 30%. The preservatives

were manually applied to the hay material using a CO_2 pressurized sprayer. Hay made at 20% moisture was sprayed with AIB and propionic acid, at a rate of one percent and with Haylosyn at a rate of .1%. Hay made at 30% was sprayed with AIB at rates of 1 and 2%; and with Haylosyn at a rate of 2%. Check bales were made at each moisture level but there was no replication of treatments at a given moisture level. After spraying, the hay was forked into a stationary twine-tie baler.

In experiment 2, alfalfa hay was baled in the field at moisture levels of 36-50% using a modified New Holland baler equipped with a storage tank, pump, and spray nozzles. As the forage was removed from the windrow by the pick-up teeth, it was sprayed with ammonium isobutyrate at rates of 0, 1.5, 2.0 and 3.0%.

Following baling, the hay from both experiments was stacked by treatment in a barn and temperatures were monitored with thermocouples inserted into the bales.

Results

Experiment 1. Temperatures for 30 days following baling are shown for the three moisture levels in Figures 1 and 2. As shown in Figure 1, hay baled at 20% moisture heated to 44 C when untreated. Spraying Haylosyn at a rate of .1% prevented heating for the first five days but following this, temperatures were not different from the untreated hay. Both propionic acid and AIB were effective in preventing heating, but hay treated with propionic acid had the lowest temperatures.

Figure 2 shows the temperatures of hay baled at 30% moisture. The untreated hay heated to a temperature of approximately 53 C. Haylosyn sprayed at a rate of 2% initially prevented heating but by the 15th day

this treatment had the highest temperature. The 1 and 2% rates of AIB were equally effective in preventing heating.

Experiment 2. As shown in Figure 3, the untreated hay heated to a temperature of 54 C. Following this initial heating, untreated hay temperatures declined to below those of treated hay. This was probably related to the loss of moisture which occurred due to extreme heating.

As rate of application of AIB increased, there was a decrease in storage temperature of the hay. However, after two weeks storage there was no discernible temperature pattern among treatments. Fluctuations in all temperatures can be attributed to some extent, to variations in ambient temperature.

Summary

When sprayed at a commercially recommended rate of .1%, Haylosyn was found to be ineffective in preventing heating of hay baled at 20% moisture. However, hay baled at 20% normally does not heat to levels detrimental to forage quality (Figures 1 and 2). Propionic acid and ammonium isobutyrate were found to be effective in preventing heating in 30% moisture hay, when applied at a rate of 1%. At higher moisture levels, increased rates of preservative were necessary to prevent heating. At 30% hay moisture levels, Haylosyn sprayed at a rate of 2% was not effective in preventing heating.

Unfortunately in the field study, the moisture content of the hay to which ammonium isobutyrate was applied was excessively high. As a result, the hay heated somewhat. However, hay to which ammonium isobutyrate was applied heated less than the untreated hay. From these results it appears that ammonium isobutyrate can be effectively applied in the field.

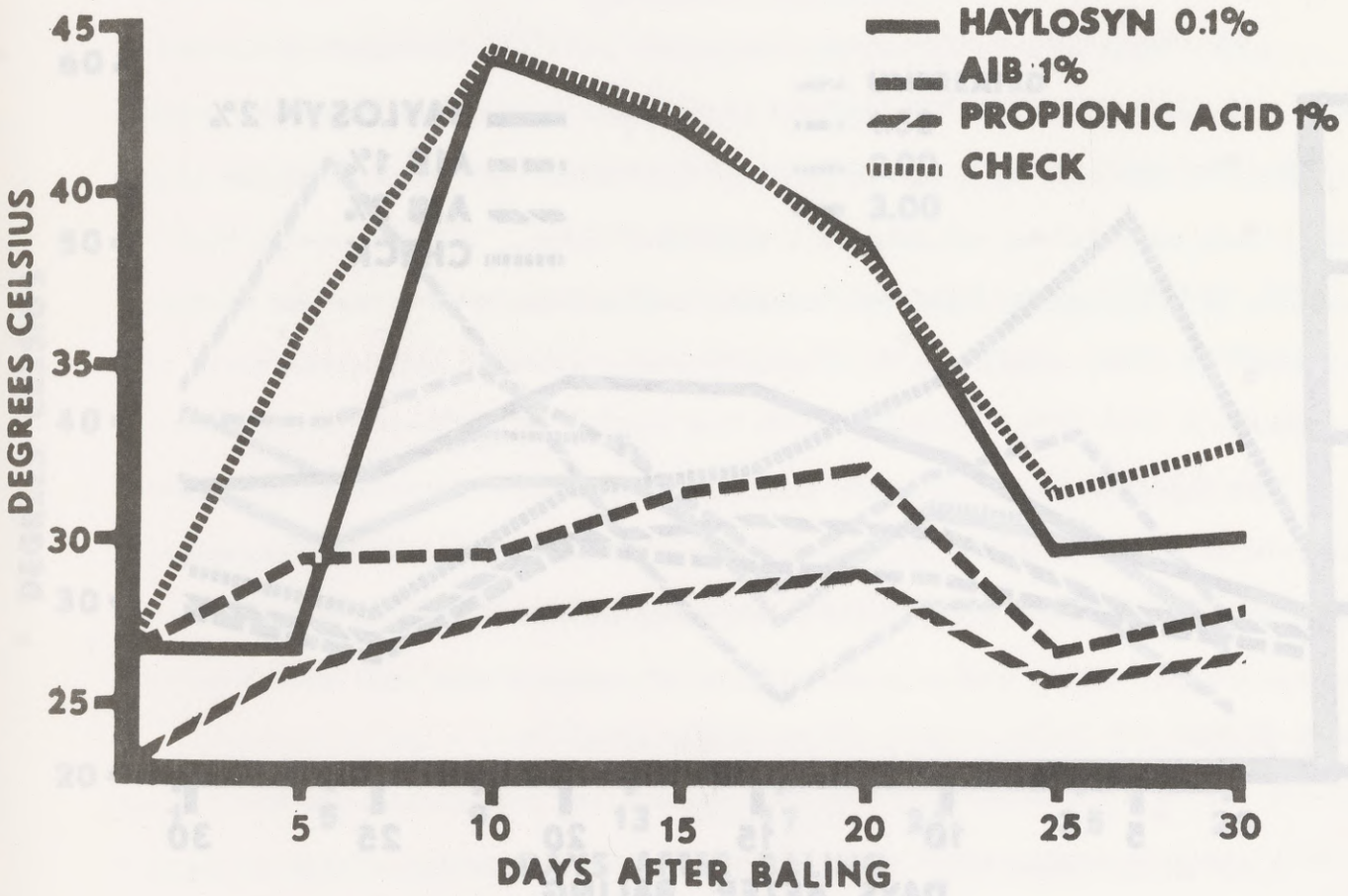

Figure 1. Average temperatures of hay baled at 20% moisture and treated with ammonium isobutyrate and propionic acid at rates of 0 and 1%; and Haylosyn at a rate of .1%.

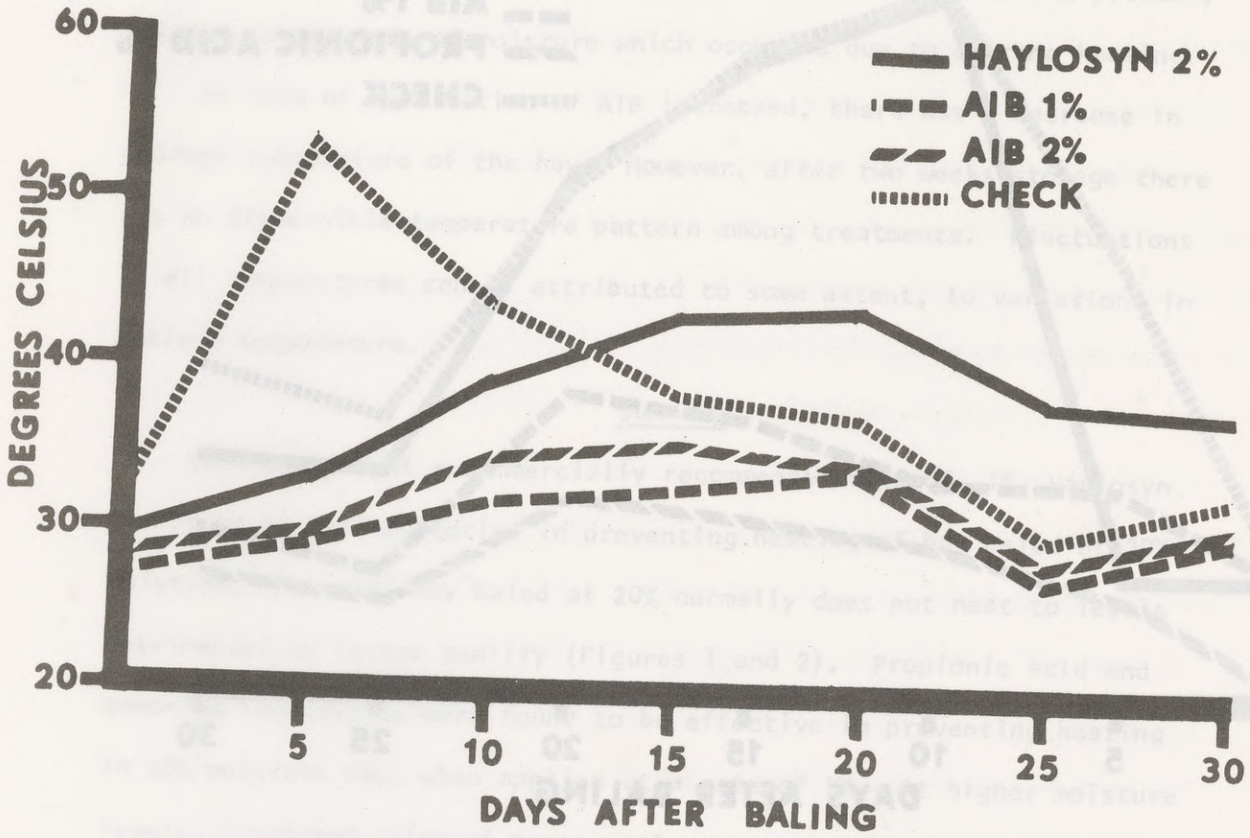

Figure 2. Average temperatures of hay baled at 30% moisture and treated with ammonium isobutyrate at rates of 0, 1, and 2% and Haylosyn at a rate of 2%.

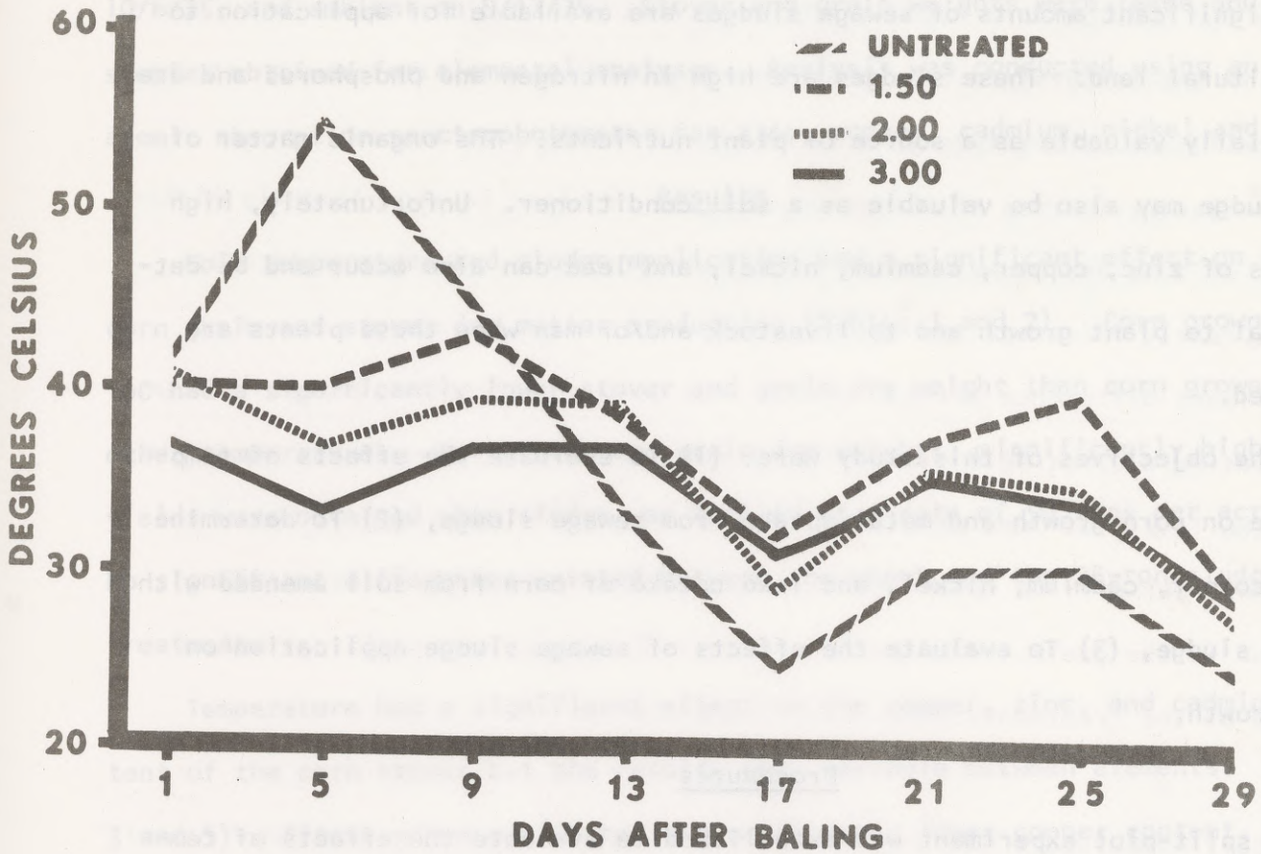

Figure 3. Average temperatures of field baled hay at 36-50% moisture and treated with ammonium isobutyrate at rates of 0, 1.50, 2.00, and 3.00%.

Corn Production and Heavy Metal Content as Influenced by Sewage Sludge Application and Soil Temperature

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Purpose and Objectives

Significant amounts of sewage sludges are available for application to agricultural land. These sludges are high in nitrogen and phosphorus and are potentially valuable as a source of plant nutrients. The organic matter of the sludge may also be valuable as a soil conditioner. Unfortunately, high amounts of zinc, copper, cadmium, nickel, and lead can also occur and be detrimental to plant growth and to livestock and/or man when these plants are consumed.

The objectives of this study were: (1) To evaluate the effects of temperature on corn growth and metal uptake from sewage sludge, (2) To determine zinc, copper, cadmium, nickel, and lead uptake of corn from soil amended with sewage sludge, (3) To evaluate the effects of sewage sludge application on corn growth.

Procedures

A split-plot experiment was established to evaluate the effects of temperature and sludges. Temperature regimes (whole plots) of 35C, 27C, 16C, and ambient were maintained on plots 15 by 6 feet. Sludge rates (sub-plot) of 0, 25, and 50 dry tons per acre were applied to plots 5 by 6 feet. Sludge rates were obtained by mixing digested sludge with a Sassafras silt loam soil with a pH of 5.8. The copper, cadmium, nickel, lead, and zinc contents of the sludge were 2200, 16, 710, 140, and 4400 ppm, respectively.

On May 27, XL-43 field corn was planted into each sub-plot in rows 20 inches apart and at a distance of two inches within rows. Plants were later

thinned to give a population of 21 plants per plot area. Tensiometers were used to monitor moisture levels and whole temperature plots were irrigated when necessary.

The corn plots were harvested when the corn grain was in the hard dent stage. The 35C plots were harvested on 9/5/75, 27C on 9/10/75, 16C on 10/6/75, and ambient on 9/17/75. Stover and grain weights were taken and samples obtained for elemental analyses. Analysis was conducted using an atomic absorption spectrophotometer for zinc, copper, cadmium, nickel and lead.

Results

Soil temperature and sludge application had a significant effect on both corn grain and stover dry matter production (Tables 1 and 2). Corn grown at 16C had a significantly lower stover and grain dry weight than corn grown at other temperatures. For stover and grain dry weights, significantly higher yields were obtained when sludge was applied at a rate of 50 tons per acre. No significant differences existed between the check and the 25-ton sludge treatment.

Temperature had a significant effect on the copper, zinc, and cadmium content of the corn stover but the results were variable between elements. (Tables 3 and 5). Plants grown at 16C had a significantly lower copper content. There were no significant differences in copper content due to the other temperatures. The highest levels of zinc and cadmium accumulation occurred at 35C and 16C, respectively. There were no significant differences due to the other temperature treatments.

Increases in the rate of sludge application resulted in significant increases in the zinc and copper content of the stover. (Table 4). Sludge application significantly increased the cadmium content of the stover, but there was

no difference between the 25- and 50-ton application rate. Neither sludge application nor temperature had a significant effect on nickel content of the stover.

Plants grown at 16C had significantly lower copper and zinc levels in the grain than plants grown at other temperatures (Table 5). The highest values for cadmium were found at 35C, but from a biological viewpoint differences in the temperature treatment were negligible. As with the corn stover, no significant temperature effects on nickel levels were found.

Increases in rate of sludge application resulted in significantly higher levels of zinc and nickel in the corn grain (Table 6). Sludge application significantly increased the copper content of the grain, but there was no significant difference between the 25- and 50-ton application rates. Sludge application did not have a significant effect on cadmium levels in the grain.

Low levels of lead were found in both the grain and stover. Less than two parts per million were found in the stover and less than one part per million in the grain. The lead content of the stover and grain was not affected by the treatments used in this experiment.

Summary

Soil temperature has a significant effect on stover and grain dry matter production. Uptake of heavy metals from sewage sludge was also significantly effected by temperature.

Sludge application resulted in higher yields of stover and grain dry matter. Higher amounts of copper, zinc and cadmium were accumulated in the corn stover and grain when sewage sludge was applied, but there was not always a difference between applying sludge at 25 or 50 tons per acre.

Table 1. Average stover dry weights of corn grown in soil amended with three rates of sludge and subjected to our temperature regimes, 1975.

Temperature	Dry Tons of Sludge Per Acre			
	0	25	50	Average
	- - - - - - - - - - Kg/plot - - - - - - - - - -			
Amb.	1.10 bc*	1.15 b	1.35 ab	1.20 X
16C	.77 d	.70 d	.89 cd	.79 Y
27C	1.30 ab	1.26 ab	1.43 a	1.33 X
35C	1.23 ab	1.40 a	1.36 ab	1.33 X
Average	1.10 B	1.13 B	1.26 A	

* Means within columns and rows followed by the same letter are not significantly different at the .05 level; capital letters are for main effects.

Table 2. Average grain dry weights of corn grown in soil amended with three rates of sludge and subjected to four temperature regimes, 1975.

Temperature	Dry Tons of Sludge Per Acre 0	25	50	Average
	- - - - - - - - - - Kg/plot - - - - - - - - - -			
Amb	1.87 a	1.87 a	2.01 a	1.92 X
16C	1.21 a	1.42 a	1.73 a	1.45 Y
27C	1.83 a	1.82 a	1.90 a	1.85 X
35C	1.79 a	1.83 a	1.79 a	1.80 X
Average	1.67 B*	1.74 AB	1.86 A	

* Means within columns and rows followed by the same letter are not significantly different at the .05 level; capital letters are for main effects.

Table 3. The effects of soil temperature on the average copper, zinc, nickel and cadmium content of corn stover+, 1975.

Temperature	Metal Copper ppm	Zinc ppm	Nickel ppm	Cadmium ppm
Amb	8.2 a*	163 b	0.37 n.s.	0.86 b
16C	6.3 b	180 b	0.55	1.18 a
27C	8.6 a	168 b	0.71	.88 b
35C	8.4 a	226 a	0.96	.99 b

\+ Soil temperature values are averaged across three sludge rates

* Means for each element followed by same letter are not significantly different at the .05 level.

Table 4. The effects of sludge application on the average copper, zinc, nickel and cadmium content of corn stover+, 1975.

Sludge Rate T/A	Metal			
	Copper ppm	Zinc ppm	Nickel ppm	Cadmium ppm
0	6.4 c*	14 c	0.67 n.s.	0.63 b
25	7.5 b	222 b	0.47	1.15 a
50	9.6 a	316 a	0.81	1.15 a

+ Sludge rate values are averaged across four soil temperatures

* Means for each element followed by the same letter are not significantly different at the .05 level.

Table 5. The effects of soil temperature on the average copper, zinc, nickel and cadmium content of corn grain+, 1975.

Temperature	Metal			
	Copper ppm	Zinc ppm	Nickel ppm	Cadmium ppm
Amb	1.81 ab*	32.0 c	0.91 n.s.	0.16 ab
16C	1.45 c	28.5 d	0.78	0.15 b
27C	1.77 ab	35.9 b	0.62	0.16 ab
35C	1.91 a	39.6 a	0.70	0.18 a

+ Soil temperature values are averaged across three sludge rates.

* Means for each element followed by the same letter are not significantly different at the .05 level.

Table 6. The effects of sludge application on the average copper, zinc, nickel and cadmium content of corn grain[+], 1975.

Sludge Rate T/A	Metal			
	Copper ppm	Zinc ppm	Nickel ppm	Cadmium ppm
0	1.51 b[*]	18.5 c	0.34 c	0.14 n.s.
25	1.87 a	39.8 b	0.66 b	0.18
50	1.82 a	43.7 a	1.26 a	0.18

[+] Sludge rate values are averaged across four soil temperatures

[*] Means for each element followed by the same letter are not significantly different at the .05 level.

The Effect of Spray Irrigation of Domestic Sewage Effluent at St. Charles County, Md. on Water Quality of the Groundwater Table of Forested Areas and Associated Drainage Streamlets

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Purpose and Objectives

Well drained soils with good percolation have been shown to be acceptable for use in rectification of wastewaters (2). Other studies have shown the "Living Filter" concept of soil for human sewage water treatment to be an effective method in treatment of such waters (1,3).

The coastal plain areas of the Eastern United States have large areas of soil with groundwater levels at or near the surface of the soil. Subsequently, this land does not easily lend itself to rectification of sewage. During the periods of seasonally high ground water levels and in coastal plain soils, there is a potential for translocation of nutrients and pollutants by surface drainage. An example of such an area is St. Charles City, Maryland where the St. Charles Utilities Company operates a series of sewage treatment lagoons and a spray irrigation system to handle domestic waste generated by a population of approximately 6,000 persons. The system appears to be operating satisfactorily. However, because of the hazards involved, careful management of the irrigation system cannot be overemphasized if the system is to function in a satisfactory manner.

The objectives of this report were:

(1) To determine the quality of water in the subsurface after spray irrigation of sewage waste waters. Nitrogen and phosphorus content was determined for hazardous levels and possible translocation within the groundwater.

(2) To determine the water quality response in the adjacent drainage streamlets.

As these seasonally high groundwater level soils have not been studied in this area, in reference to human sewage rectification; and the fact that many small communities are present in these areas, pointed out the need for this study.

Procedure

Groundwater was sampled using plastic filter candles imbedded in the soil at groundwater levels. These candles were used in conjunction with a vacuum pump and vacuum canisters. Phosphorus analysis was conducted on water samples utilizing an ascorbic acid - ammonium molybdate colorimetric method. Free ammonia and nitrate nitrogen were determined in the water samples utilizing Devardo's alloy in Macro-Kjeldahl distillation.

Results

The sampling sites of both the subsurface filter candles and stream samples are shown in Figure #1. All data for the phosphorus and ammonia and nitrate nitrogen analyses are listed in Table 1 and 2.

The subsurface water samples obtained with filter candles showed no appreciable amount of phosphorus or ammonium; however, the nitrate at times reached levels close to the upper limit for potable waters (10 ppm) (Table 2). There are at present three different streamlets associated with two large irrigation fields; they drain the northern, eastern and southern boundaries of both fields. The southern drainage streamlet showed evidence of minor phosphorus addition due to runoff from irrigation field #2. However, most of the phosphorus was assimilated into the streamlet approximately 1 mile downstream. The eastern streamlet showed some evidence of periodic phosphorus addition due to runoff from spray irrigation field #2. However, the phosphorus was relatively minor in quantity and usually assimilated into the stream approximately 2/3 mile downstream.

The northern streamlet adjacent to irrigation field #1 showed evidence of definite phosphorus addition from the field. The nutrient addition was minor in quantity. Generally, stream pollution in this system was affected in two ways. First, any excessive amount of irrigation overloaded the system. This resulted in overland flow into the adjacent streamlet. Secondly, faulty placement of a few spray nozzles without regard for local topographical changes contributed to effluent accumulated in low lying areas and this eventually ran off some of this accumulation into adjacent streamlets. Both problems are easily amended by changes in irrigation rates and alteration of spray irrigation equipment.

Summary

Spray irrigation fields and drainage streamlets adjacent to the St. Charles Utilities Sewage Treatment Facility were analyzed for possible hazards resulting from the irrigation effluent.

Nearly normal levels of phosphorus and ammonium-nitrogen were detected and nitrate nitrogen was detected in the groundwater samples. Although phosphorus was detected in the streamlets as a result of surface drainage from the irrigation sites, most of these nutrients were assimilated by the vegetation and soil associated with the streamlet within a mile of the source.

In conclusion, the environmental impact of the St. Charles Utilities Sewage Treatment Plant was negligible as compared to a similar size conventional sewage treatment plant which would have released its treated sewage into the local waterway.

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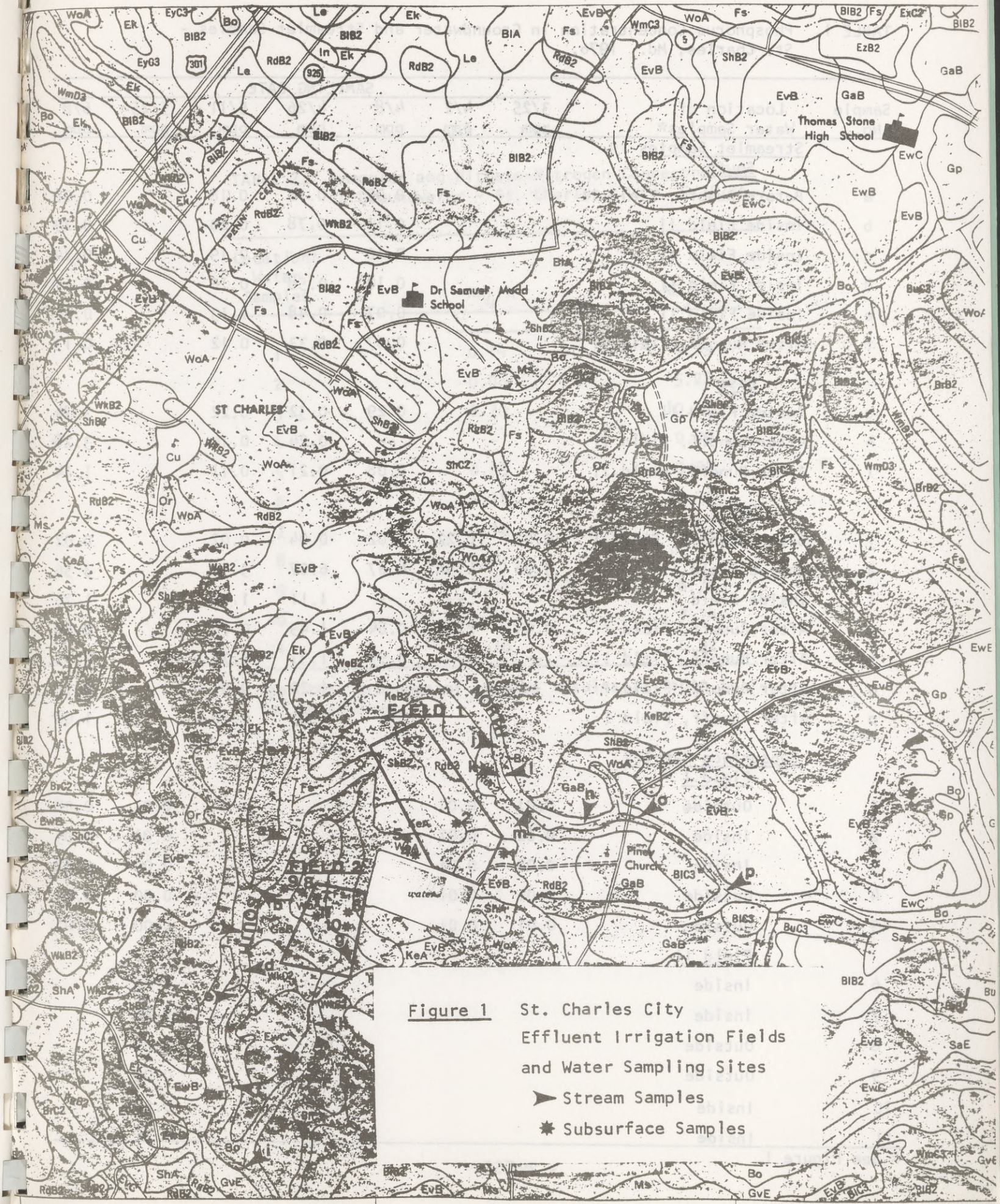

Figure 1 St. Charles City Effluent Irrigation Fields and Water Sampling Sites

➤ Stream Samples

✸ Subsurface Samples

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TABLE 1. Phosphorus Concentration in Groundwater and Streamlet Samples - St. Charles, Md. 1976.

Sample No.	Location of Water Samples*	SAMPLING DATE 3/25 ppm	4/2 ppm	4/8 ppm	4/26 ppm	5/11 ppm	5/25 ppm	6/8 ppm
	Streamlet Samples							
	South							
a	Before Runoff, Field II			0.05	0.16	0.18		0.06
b	Inside Field II			0.11	0.78	0.20		0.29
c	Inside Field II			0.10	--	0.19		0.24
d	Inside Field II			0.10	0.58	0.16		0.17
e	Inside Field II			0.07	0.48	0.13		0.14
f	After Runoff, Field II			0.07	0.33	0.12		0.13
	East							
g	Inside Field II			0.29	0.32	0.22		3.74
h	After Runoff, Field II			--	0.24	0.14		3.28
i	After Runoff, Field II			0.08	0.21	0.11		1.14
	North							
j	Before Runoff, Field I	0.02	0.22	0.02	0.04	0.02		0.02
k	Inside Field I	3.06	4.98	4.67	6.07	3.51		3.36
l	Inside Field I	--	--	--	1.11	1.16		1.76
m	After Runoff, Field I	0.44	2.46	0.84	1.45	0.78		0.66
n	After Runoff, Field I	--	--	0.59	1.31	0.70		0.76
o	After Runoff, Field I			--	1.20	0.91		0.72
p	After Runoff, Field I			--	1.03	0.70		1.00
	Subsurface Samples							
	Field I							
1	Outside	0.01	0.01				0.01	0.08
2	Inside	0.02	0.02				0.01	0.03
3	Inside	0.02	0.01				0.00	0.02
4	Outside	0.01	0.01				0.00	0.02
5	Outside	0.01	0.01				0.00	0.03
	Field II							
6	Inside						0.03	
7	Inside						1.84	
8	Outside						0.02	
9	Outside						0.01	
10	Inside						0.00	
11	Inside						1.90	

* See Figure 1.

TABLE 2. Ammonium and Nitrate-Nitrogen Concentration in Groundwater - St. Charles, Md.* 5/25/76.

Location* Water Samples	NH_4-N	NO_3-N
	ppm	
1	0.14	2.39
2	0.08	5.22
3	0.70	10.22
4	-	0.79
5	0.05	0.53
6	0.18	12.39
7	0.12	12.43
8	0.11	11.41
9	1.00	8.76
10	0.10	7.74
11	1.10	6.92

* See other groundwater samples results in Table 1 for phosphorus.

Grass Buffer Strip Control of Fecal Pollution in Surface Runoff

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Purpose and Objectives

The United States is confronted with the combined problem of disposing of 7.3 million tons of sewage sludge and 2.0 billion tons of cattle manure per year in a manner that is both economically feasible and environmentally safe. One approach to the disposition of sewage sludge and manure is land application. Presently, crop and forest-land application and land reclamation are the major sludge and manure utilization methods. Although benefits to crop yields and soil fertility are fully documented, the addition of human and animal wastes to the soil is not without potentially undesirable effects. One principal concern is the microbiologic pollution of surface waters with organisms capable of causing disease and ill health.

This project was designed to evaluate the effectiveness of grass buffer strips in controlling the movement of bacteria transported in surface runoff originating from surface application of municipal sewage sludge and dairy manure. Primary emphasis was directed toward the movement of fecal coliforms and fecal streptococci during rainfall events.

Procedure

A ten percent, uniformly sloped, Chester silt loam soil at the University of Maryland Dairy-Forage Research Farm served as the research site. Uniform groundcover was established with Ky31 tall fescue. A randomized complete block design with duplication of control and treatments was utilized. Application and runoff areas were defined with polyethylene edging to produce separate

micro-watersheds for each treatment and control. Sludge and dairy manure were applied at the rate of 50 and 14 dry tons per acre, respectively. Runoff samples from each treatment and control were collected at 0.0, 1.6, 4.9, and 13.1 feet with dustpan lysimeters and analyzed for fecal coliforms and fecal streptococci. The parameters were evaluated under defined characteristics of rainfall and post-application time lapse. Extraneous fecal pollution from small animals and runoff from the upper hillside was limited by fencing and diversion channels, respectively.

Samples were analysed as representative aliquots of total runoff from each micro-watershed. Fecal coliforms were evaluated with the multiple tube fermentation technique and fecal streptococci were enumerated by the pour plate technique.

Results

The fecal streptococci (FS) and fecal coliform (FC) values for two distances and two rainfall events are summarized in Table 1. Statistical evaluation was applied to treatments vs. control and distance comparisons within treatments within rainfall events.

The first rainfall event represents a light rainfall with intermittent periods of low intensity precipitation lasting 10.25 hours with a total accumulation of 0.75 inches of rain occurring 10 days after treatment application. Fecal coliforms were not detectable at the 0.0 or 13.1 feet distance for the sludge and manure treatments. Control FC values were quite low at 0.0 foot and not detectable at 13.1 feet. Fecal streptococci values significantly increased at 13.1 feet with both sludge and manure, but, the values were of a low magnitude. Fecal streptococci values for the control were low at both distances with a significant decrease related to distance being observed. Sludge FS values were less than the control at 0.0 foot and similar to the control at 13.1 feet. Fecal streptococci values for the manure treated plots were significantly

greater than the control at both distances. The increases in FS at 13.1 feet are probably due to extraneous bird and rodent fecal contamination. The low intensity and total rainfall apparently did not overburden the hydraulic capacity of the soil. Also the rainfall lacked sufficient energy to dislodge particles of manure or sludge and create a flow of suspended particulate matter laden with organisms. Renovation of surface runoff was enhanced due to the low volume and velocity of flow. This allowed greater sorptive and filtrative reaction time.

The second rainfall occurred 36 days after the application of sludge and manure. The rainfall event lasted 24 hours with a total accumulation of 5.80 inches. A significant decrease in FC directly related to distance was observed with the sludge and manure treated plots. The magnitude of the counts at the 0.0 foot distance signifies a viable population of FC remaining five weeks after application of the sludge and manure. Fecal coliform values for the treated plots were significantly higher than the control at both distances. Fecal streptococci values decreased with distance from the sludge treated plots and were low at both distances from the manure application. The control and manure plots exhibited similar FS values at 0.0 feet and the control and sludge FS values were similar at 13.1 feet.

Summary

The movement of fecal coliform and fecal streptococci bacteria in polluted surface runoff can be significantly reduced by grass buffer strips. However, the size of the buffer zone required appears to be dependent on the quantity and intensity of rainfall. During a rainfall event of 5.8 inches in 24 hours, a buffer strip of 13.1 feet was not adequate to reduce fecal coliform numbers to background levels under the conditions of this study.

Table 1. Fecal coliform and fecal streptococci levels in surface runoff originating from a Chester silt-loam soil on a 10% slope when amended with surface applications of sewage sludge (50 dry T/A) and dairy manure (14 dry T/A).

Post Application (days)	Runoff Distance (feet)	Fecal Coliforms			Fecal Streptococci		
		Sludge	Control	Manure	Sludge	Control	Manure
		MPN/100 ml [1/]			MPN/100 ml X10^3 [2/]		
10	0.0	0a [3/]	7.0b	0a	0.1a	20.0b	30.0a
	13.1	0a	0.0a	0a	4.5b,c	2.7c	57.0b
36	0.0	18,000a	4.6b	40,000a	18.0a	5.0b	2.7a,b
	13.1	3,300b	11.4a	810b	5.0b	8.7b	1.8a

1/ Values represent geometric means of two samples.

2/ Values represent geometric means of 6 plate counts (2 samples, 3 plates each).

3/ Means within treatments and within a rainfall event with similar letters are not significantly different at the 5% level of probability using the Mann-Whitney Test. Means of treatments compared to the control within distance and rainfall event with similar letters are not significantly different at the 5% level of probability using the Mann-Whitney test.

Residual Effect of Thirteen Cropping Systems on Corn Yield and Soil Aggregation

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Purpose and Objectives

To determine the residual effect of thirteen cropping systems with two levels of nitrogen (100 N and 200 N) on corn yields and soil aggregation.

Procedure

Eighty-one plots on Beltsville silt loam soil that had been in thirteen cropping systems from 1952 to 1973 were put in corn in 1973. Continuous corn has been in these plots each year since 1973 to determine the residual effect of the cropping system. Soil samples were taken on July 2 for soil aggregation and soil organic matter determination. Corn yields were determined on all plots.

Results

The corn yields, soil aggregation and soil organic matter content are presented in Table 1. Since all plots were put in corn, it was possible to compare third year corn following a grain or hay crop with fourth year corn following the same rotation.

Summary

Corn yields were more closely correlated with soil aggregation than with soil organic matter and unlike previous years the correlation was low probably because of the high rainfall in 1975. Differences due to previous cropping systems continued to be evident but the continuous cropping to corn caused the differences to be smaller. The plots that had the lowest aggregate stability and organic matter because of the bare fallow treatment continued to improve in corn yield while the plots formerly in continuous grass continued to decline in corn yields. The difference between the lowest corn yield (56 bu. on bare fallow) and the highest yield (121 bu. on corn, wheat, 3 yr. of orchard grass rotation) was much less than the 100 bu. difference obtained between plots in these two systems in 1973 which was the first year of continuous cropping to corn following the 20 years of differential cropping.

Table 1. Corn yields, soil aggregate stability, and soil organic matter content in 1975 of plots on Beltsville silt loam soil that had been in thirteen different cropping systems from 1952 to 1973 and continuous corn since 1973.

Cropping System and Previous Crops (1952-72)	Corn Yields (1975)			Soil Aggregation 7/2/75	Soil Organic Matter 7/2/75
	100 N	200 N	Ave.		
	bu/A	bu/A	bu/A	%	%
Cont. Bare Fallow	64.3	47.6	55.9	7.0	1.22
Cont. Corn	67.6	76.6	72.1	10.7	1.57
Cont. Soybeans	87.6	106.5	97.0	10.1	1.64
Cont. Bluegrass	122.6	119.1	120.8	21.6	2.02
Cont. Orchardgrass	124.5	97.9	111.2	19.3	2.09
Cont. Wheat	126.9	116.2	121.6	18.3	1.85
C°, W	79.7	76.0	77.9	19.2	1.73
C°, W*	90.6	89.6	90.0	13.9	1.80
C, W	103.2	91.2	97.2	13.5	1.75
C, W*	96.9	76.4	86.6	13.9	1.65
SwC, W	93.9	96.9	95.4	15.2	1.67
SwC, W*	89.4	81.3	85.3	12.3	1.68
C, S, W	96.5	116.9	106.8	14.3	1.69
C, S, W*	110.0	98.6	104.2	13.1	1.81
C, W, H	109.5	97.4	103.4	16.7	1.77
C, W, H*	91.8	106.9	99.4	11.5	1.75
C, W, H, H	99.4	106.5	102.9	13.7	1.86
C, W, H, H*	104.3	126.2	116.1	15.4	1.98
C, W, P, P, P	125.3	116.6	120.9	18.4	1.92
C, W, P, P, P*	98.7	101.9	100.3	15.3	1.83
Ave. 3rd year corn	101.1	100.2	100.6	15.9	1.77
Ave. 4th year corn	97.4	97.3	97.4	13.6	1.79

*These plots were followed by 4 years of continuous corn. Others were followed by 3 years of corn.
C° = corn with stalks left on; SwC = sweet corn; W = wheat; H = alfalfa hay; P = orchardgrass and ladino clover; S = soybeans.

Correlation coefficient (r) between corn yield and soil aggregation = +.44 with n = .52. The correlation coefficient between yield and organic matter was +.28 and between aggregation and organic matter was +.52.

The Role of Oxidation in the Formation of a Maryland "Cat Clay"

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Purpose and Objectives

The weathering of sulfides to form acid sulfate soils, often referred to as "cat clays", is a unique problem common to recently exposed sulfide-bearing sediments throughout the world. Typically, sulfidic sediments have been deposited in tidal marsh environments where anaerobic bacteria have reduced sea water sulfates to form iron sulfides or pyrite. Upon exposure of sulfidic sediments to the atmosphere, rapid oxidation of pyrite brings about formation of sulfuric acid. "Cat clays" are characterized by excessively low pH values (pH values of 2 or lower are not uncommon) and a lack of vegetation when exposed at the surface.

In the course of investigating soils associated with the reddish Cretaceous clays of Maryland, soils with "cat clay" properties were found to occur in close proximity to reddish clays. Subsequent investigation of "cat clay" occurrences in Maryland has resulted in the location of numerous "cat clay" exposures in various areas of the Western Shore Coastal Plain. The following study was designed to demonstrate the role of oxidation in the weathering of sulfidic sediments.

Procedure

A "cat clay" exposure was sampled at various increments to a depth of 250 cm using a bucket auger with extensions. The pH of all samples was determined prior to air drying. Analyses for total sulfur content were determined by X-ray spectroscopy.

Results

The "cat clay" studied in this investigation was known to have a surface pH of 2.5 and was chosen for this study because of its situation on relatively level terrain. The "cat clay" is located near the intersection of the Capital

Beltway and Central Avenue. Several "cat clay" outcrops are exposed in this area, thus indicating a rather extensive deposit of sulfidic sediments. The "cat clay" situation has developed since the sulfidic sediments were exposed by excavation connected with the construction of the Beltway.

The profile consisted of relatively uniform material having a sandy loam texture. Colors ranged from dark olive gray (5Y 3/2) near the surface to black (5Y 2.5/1) below 36 cm. Pale olive (5Y 6/4) mottles, probably indicative of jarosite precipitation, were present in the upper 36 cm of the profile. Jarosite is a potassium iron sulfate mineral that forms from elements dissolved under the very acid conditions of "cat clays". Below the 36 cm depth, shell fragments were present in somewhat variable amounts. The water table was not encountered within 250 cm.

Figure 1 shows the pH and sulfur content distribution with depth in the "cat clay" sampled. The most acidic portion of the soil occurs at and just below the soil surface, where pH values average less than 2.7 to a depth of about 23 cm. Below this the pH rises sharply and reaches a maximum of over 8.3 at depths below 63 cm. The most dramatic change in pH occurs between 30 and 40 cm where the pH abruptly rises from 4.1 to 7.1.

Oxidation of sulfidic compounds contained in the sediment is suspected as the most likely reason for the low pH values indicated, since it is known that sulfidic compounds remain stable only so long as free oxygen is not present. Prior to construction of the Capital Beltway the sulfidic sediments were most likely protected from the atmosphere by overlying materials. Excavation and overburden removal appear to have exposed fresh sulfidic sediments to an oxidizing environment. The production of sulfuric acid by the oxidation of pyrite is expressed as:

$$FeS_2 + 3\tfrac{1}{2}O_2 + H_2O \longrightarrow Fe^{2+} + 2\ SO_4^{2-} + 2H^+$$

From the values presented in Figure 1, it is apparent that the zone of oxidation is limited to approximately the upper 40 cm of the profile. Below 40 cm, pH values are indicative of reduced, undisturbed sediments. Under undisturbed conditions, $CaCO_3$ from shell fragments appears to control pH levels in this sediment. In the oxidized zone near the surface, sulfuric acid has been released in quantities sufficient to neutralize all basic compounds and bring about the acidic levels indicated. Distribution of sulfur in the profile indicates that the lower pH values near the surface have not resulted from originally higher concentrations of sulfidic minerals at this point, but rather greater oxidation rates. Since sulfur contents are actually lowest near the surface, a loss of sulfur from this zone, probably by the leaching of sulfates, is believed to have occurred.

Summary

Sulfidic sediments may become highly acidic when exposed to oxidizing conditions. The present zone of oxidation in the "cat clay" studied appears to be restricted to the upper 40 cm, even though similar parent material extends below this depth. Sulfide content in this sediment is apparently high enough for sulfuric acid to have been produced in quantities exceeding the amount needed to neutralize any carbonates present. Relatively low sulfur concentrations near the surface suggest a loss of soluble sulfates from the profile has occurred.

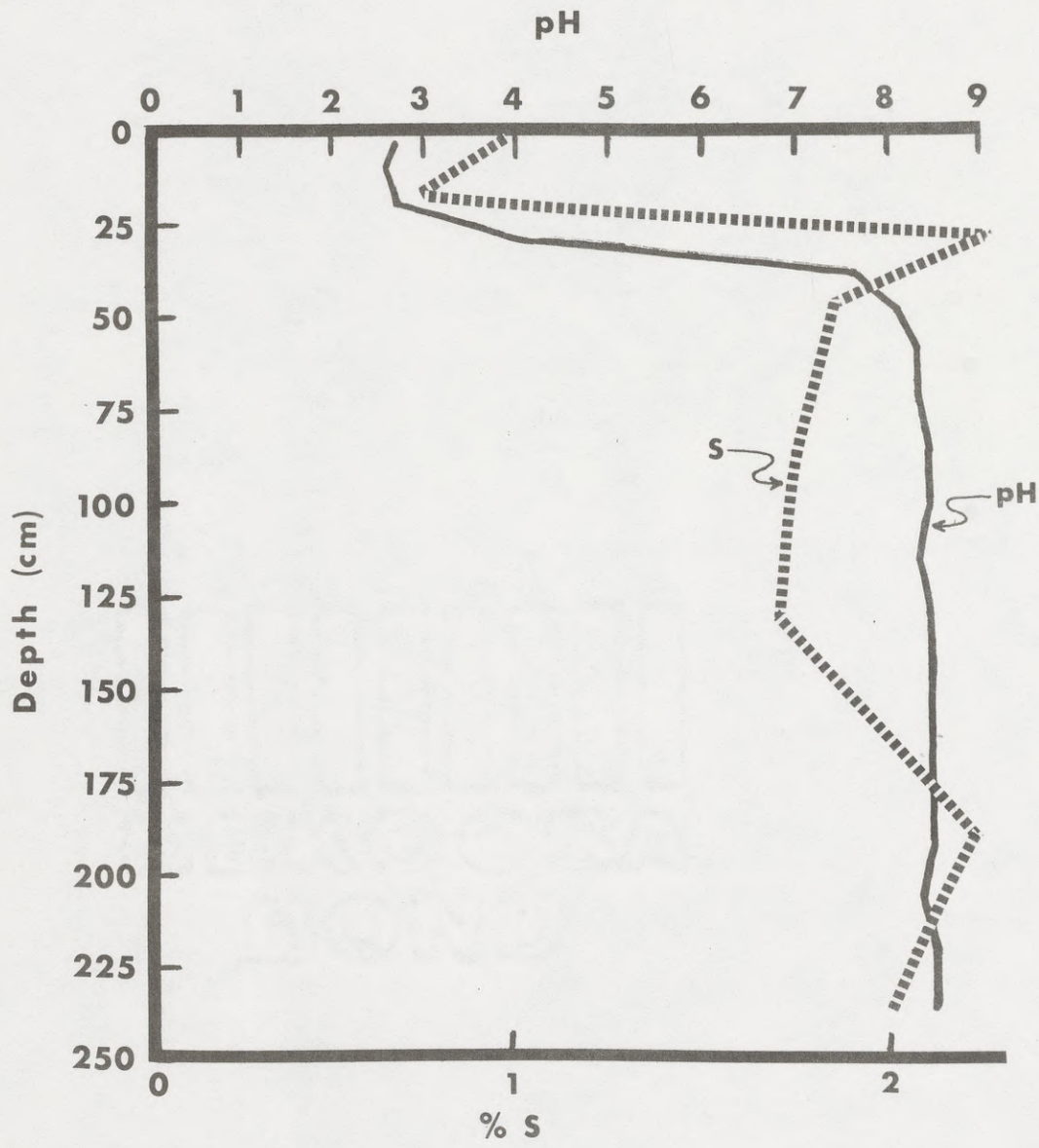

Figure 1. Distribution of pH and sulfur with depth in a Maryland "cat clay."